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Next Issue

FIFTY-NINTH ANNUAL REVIEW NUMBER,

comprising articles by mining company executives, engineer-operators, government bureau officials, and editors of the *E. & M. J.*, and other leading mining publications abroad, on fifty of the more important metals and non-metallic minerals; technical reviews by specialists on each phase of mining and metallurgical operations; a summary of world mining developments; a discussion of outstanding economic problems; a review of industrial progress; and a mass of statistics, charts, and graphs.

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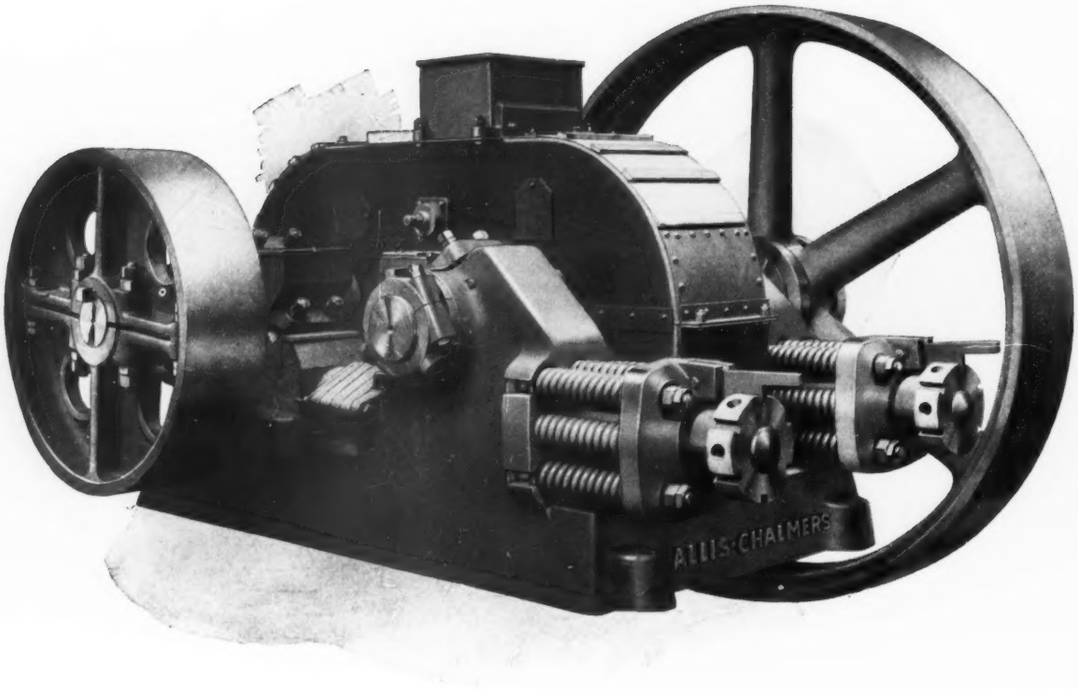

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Physician Proposes Remedy for Profitless Sales

AFTER a professional diagnosis, which other members of Congress felt disinclined to undertake, Dr. Royal S. Copeland, United States Senator from New York, on Jan. 4 introduced, jointly with Representative Meyer Jacobstein, of the same state, a bill designed to exempt the bituminous-coal industry from the provisions of the federal anti-trust laws. If enacted by Congress and accorded executive approval, the statute will create a third legally favored class, officially certified as of such moral status as safely to be trusted with the conduct of its business. No well-informed citizen will deny that the bituminous coal industry is "sick"—chronically and dangerously "sick." Cut-throat competition, resulting from an excess of productive capacity, has reduced it to a state bordering on helplessness. Appropriately enough, a qualified physician answers a night call, so to say, in its extreme emergency.

Miners of some of the metals and of minerals other than soft coal should derive encouragement from the action of Doctor Copeland and Representative Jacobstein. A joint statement issued on Jan. 3 declares:

> "By the bill which we will introduce it will be lawful, but purely voluntary, for bituminous coal mine owners and distributors to organize themselves into co-operative trade associations. These associations will be permitted by law to regulate not only the mining but the marketing of coal. If these associations function properly, many of the high cost mines will go out of business. Many of the surplus workers will be transferred to other industries by an intelligent and humane procedure. The drawing into the industry of casual labor in boom times will disappear.
>
> "We believe that through these co-operative associations the great waste that now occurs in cross-hauling of coal across the country will be eliminated."

That the reasoning applies with identic cogency and force to some other industries needs no emphasis. Certain non-ferrous metal-mining industries might well benefit from such medicine. "Class" distinctions, moreover, whereby coal would be favored over metal mining, should have no place in national legislation. Such legislation will command public sanction and support only if it is morally sound.

It is evident that Senator Copeland and Representative Jacobstein regard the Sherman and Clayton acts as factors in "restraint of prosperity," to quote the title of an article attacking these laws by Mr. James J. Davis, Secretary of the United States Department of Labor, in *The Saturday Evening Post* of Dec. 31, 1927—a pronouncement even more specific and emphatic in its condemnation of the Sherman Act and in its recital of the evils of cut-throat competition than the editorial on the same subject printed in the Nov. 5, 1927, issue of *Engineering and Mining Journal*. Secretary Davis, however, confined his discussion to the bituminous coal industry, with which this journal is not directly concerned; but his conclusions apply with equal force to every other mining industry in which any large numbers of its constituents are suffering from profitless selling prices.

When unrestrained and unregulated competition results in criminally wasteful destruction and consumption of the natural resources of the earth, in which every inhabitant from now to the end of time has an equal, legitimate and moral stake and title, economists, statesmen, and industrialists possess the mightiest incentive to unite in an effort to prevent continuation of conditions which none familiar with facts can defend. That existing law has for thirty years encouraged an unwise expansion of operations in an indiscriminate scramble for profits, warrants consideration of existing conditions. The Copeland bill invites such consideration and analysis.

To achieve whatever results the existing opportunity makes possible requires action. Speculation as to why the representatives of our mining states have left to a Senator and a Representative from New York—a state in which never a pound of soft coal was mined—the important business of attempting a needful legislative reform will get one nowhere, however interesting and politically significant the fact may be. Undoubtedly, once the bill presented by Senator Copeland and Mr. Jacobstein gets into committee, an attempt will be made to amend it so as to cover "sick" mining industries other than the soft-coal business. If this be not done, responsibility for the result will lie with those industries equally in need of consideration. Let them cry out for some of the medicine that has been prescribed for the soft-coal patients.

Legislators, to act intelligently, honestly, and courageously, must be made cognizant of the needs, the opinions, and the aspirations of their constituents. If convinced that a mining industry in their districts is in law and morals as fully entitled to exemption from provisions of the anti-trust laws as agriculture, labor, and the soft-coal industry, it is certain that representatives in Congress of those states where such mining is a basic and important industry will aid in the correction of what may be considered a discriminatory inhibition.

Those components and representatives of mining industries who are satisfied with the existing status with regard to production and sale may leave to coming generations the task that circumstance may create. To those, however, who know the facts—who realize that all is not well—the suggestion is made that they at once establish contacts, personally or through correspondence, with their representatives at Washington, expressing themselves freely—asking frankly for what they want and making plain the reasons for their demands. Let the ear that is to the ground hear something—something loud.

If your industry is, in your opinion, approaching the chaos that characterizes the soft-coal business, and if on due consideration you feel so disposed, write to your representative in Washington demanding the amendment of the Copeland bill so that it will include, in its exemptions, the mining industry in which you are interested; and urging that, as so amended, the bill be enacted into law.

Air Refrigeration as a Phase of Mine Ventilation

THE inevitable factors that will influence mining operations as time goes on will include the problem of working at increasingly greater depths. More heat will be encountered, and an atmosphere must be provided in which humans can work with comparative comfort and effectiveness. The temperature, the humidity, the purity of the air—each must be made suitable. No one today questions the advantage—indeed, the necessity—of providing a working atmosphere that is not only bearable but that meets in every respect certain standards of quality determined by research as the most desirable.

Aside from considerations as to the ultimate effect on the health of the worker, it has been demonstrated that the maintenance of proper conditions underground more than repays the mining company for the additional expense involved. Those in charge of such operations know that the decrease in efficiency of the worker becomes marked under even moderately bad conditions of temperature and humidity. Unconsciously to him, his output is diminished. Moreover, the hazard of accident in hot and humid working places is known to be much greater than where conditions are reasonably comfortable. A striking result of the installation of a cooling plant at Morro Velho, in Brazil, was the decrease in the accident rate. This resulted not only in substantial cash saving in compensation liability, but it avoided much of the intangible loss that always accompanies the demoralization resulting from serious accidents.

The development of mine ventilation has to a large extent merely kept pace with necessity. In a small and shallow mine, perhaps with a little assistance, Nature provides enough fresh air to enable miners to work reasonably well. Mines that are deeper, with more extensive lateral workings, usually are equipped with fans, placed in more or less haphazard fashion, to force fresh air where it is needed. But as greater depths have been reached and as temperatures have become higher, and as the realization has grown that the condition of the atmosphere is a vital element in the efficiency of the workers, collectively and individually, elaborate and carefully designed ventilation systems have been introduced. The ventilation engineer has become an important official at every large mine.

An excellent example is the work of the Anaconda Copper Mining Company. During the last seven years considerably more than one million dollars has been spent in carrying out a ventilation program at Butte. Certain shafts have been set aside exclusively for ventilation, and specially lined to reduce resistance to the flow of air. Huge motor-driven fans have been installed on the surface to pump air into the mine or to draw it out. Scores of booster fans and thousands of feet of metal pipe and canvas tubing have been placed underground. Doors and bulkheads have been provided to direct the air currents into the desired channels through the workings. By supplying fresh air in adequate volume, and by "pumping" it to the working places where it is needed directly and quickly, so that it absorbs the minimum of heat on the journey, excellent conditions are maintained. The company is now preparing to mine at depths down to 5,000 feet—more than 1,000 feet deeper than the horizon of the principal stoping areas today. It is believed that no change in the method of ventilation will be required at that depth.

But what of 6,000 feet or more? And there seems to be no reason to doubt that the orebodies will continue to that depth. Elsewhere in the world it has been found desirable to adopt supplementary measures for conditioning mine air. In Brazil, refrigerated air is blown into the Morro Velho mine; ice is carried down some of the mines on the Rand in South Africa, where a depth of 7,650 feet has been reached in the Village Deep. A logical step is to study the methods and equipment used for conditioning the atmosphere in theaters and factories, where many plants of this character are in successful and profitable operation. In the issue of *Engineering and Mining Journal* of January 7, Mr. E. G. Lawford, of Rio Tinto, Spain, discussed the operation of air-conditioning plants, and suggested some of the problems that would arise in applying the same methods to mine ventilation. The time has perhaps arrived when, at some mines, costs could be reduced by the introduction of modern methods for conditioning air. In any event, it seems certain that ultimately the need will become general for a method of refrigeration to provide satisfactory atmospheric conditions in mine stopes. The problems involved are so considerable, however, and the successful solving of them is so important, that more research under practical operating conditions should be undertaken, and at once.

The Scope for an Extension of Engineering Education

FROM the Society for the Promotion of Engineering Education comes the announcement that a fund has been provided by certain educational institutions and the Carnegie Corporation for an investigation of engineering education, to parallel that recently conducted by the colleges. The new inquiry is to determine the character and extent of the need in the United States for a type of technological education that is more advanced than that given in the secondary schools; that affords a general preparation for technical, supervisory, and commercial services in industry, rather than specific training for skilled trades and occupations; that differs from the programs of the engineering colleges in being briefer, more intensive, and more direct in method, less theoretical and more strictly technical in character and not leading to an academic degree—principally full-time and co-operative day courses, not excluding evening and extension courses organized into extended curricula.

It is also planned to determine (1) the extent and character of existing educational facilities of this character and to appraise their effectiveness; (2) the means by which the needs may be met more adequately; how institutions giving this type of technological education

and the existing engineering college may supplement one another's efforts so as to create a well-balanced system of higher technical education; and (3) how the public educational authorities, the professional engineering societies, and industrial bodies may aid in establishing this type of education on a stable and adequate basis.

The most pressing need in the field of engineering education today is undoubtedly the extension rather than the restriction of the regular courses. The inquiry promised should provide data of interest and value to all concerned.

"In the Making of Books"

IN A RECENT ISSUE of the New York *Times,* a suggestive article by Mr. Simeon Strunsky draws attention to the need for more care in the preparation of books and less evasion in the reviewing of them. He maintains that many characteristics of American civilization need to be "challenged, exposed, debunked, and uprooted," but adds that he considers it only fair that those who write the books of 1928 "should do their own challenging and devastating, instead of leaving most of the hard work to . . . the reader." He then gives a typical book review of a certain type, as follows: "E. F. Robinson's 'The Economic Pulse' overstates the area of the United States by 100 per cent. It understates the population by 50 per cent. In the matter of wages and prices the author has made use of the census of 1890 when the census of 1920 was available. He confuses Portland, Me., with Portland, Ore. Nevertheless, the book cannot fail to act as a challenge to our established superstitions and complacencies in respect to the economic status of the American people." Thereupon Mr. Strunsky presents a parallel treatment of another subject in the same style: "Out of a dozen extra prime white fresh eggs at the market price of $1.10 the housewife will probably find not more than four or five eggs suited for the breakfast table. But this very element of chance brings a fresh breeze into the standardized routine of the American breakfast table. It disposes of the ancient taboo which exacts twelve fresh eggs out of a dozen fresh eggs at $1.10 a dozen."

Why, he asks, should not writers consult a cyclopedia or obtain correct basic information at the nearest public library? "Why has it come to be accepted as a positive virtue when the data are not right and the names are misspelled? Why the contrary suggestion that a judicious preparation of the manuscript means stodgy conservatism and lack of vision? And why the general principle that it is up to the reader of a book to make the best of a book and not up to the writer?"

Before us is a well-bound and nicely printed volume on South America, its industries and commerce; and a hasty glance through it indicates that Mr. Strunsky's general complaint about books is justified. At Chuquicamata, we are told, "Ten of the 2,080 shafts are over 1,000 feet in depth, and at 1,500 feet the ore is of commercial value." And again: "Commercial nitrate is a white, cheese-like substance, which is used in manufacturing the highest grade of gunpowder, also to produce nitric and sulphuric acid. . . ."

Much that is published provides inspiration and data of practical value, but the responsibility of the author in regard to accuracy is not generally accepted. Perfection is not expected, but the reviewer's task often presents insuperable difficulties, and a compromise usually ends in the type of comment to which Mr. Strunsky draws attention and to which he rightly takes exception.

Light Duty for Convalescents in the Mining Industries

AFTER a two-year experimental trial, one of the large copper companies operattng in Arizona has announced the details of application of a method of utilizing sick and injured workmen at full pay, which has proved an economic success as well as an effective welfare measure. This is brought about by employing them in a salvage department, in which the many miscellaneous repairs and other light tasks, common to all mining operations, are performed. The plan, in fact, was the direct outgrowth of the establishment of this salvage department, which was introduced primarily to reclaim worn-out equipment, however, rather than to provide useful work for employees who were temporarily impaired physically as a result of accident or sickness.

A study of convalescent workers, prior to the adoption of the plan, showed that, being physically unfit to resume regular underground labor, they were inclined to become discontented, owing principally to the fact that, although living expenses showed no material diminution during the enforced idleness, the income from disability compensation was only about half the regular wage. Also, a continuation of the study revealed that, in many instances, even after being returned to regular duty, the remembrance of lost time and money continued to depress them and to affect adversely their capacity for normal work.

Under the new plan convalescents who are pronounced by the company physician to be physically able to perform light labor have replaced full-time employees in the salvage department. The result is of benefit to all concerned. Convalescent workers are returned to full time much sooner than formerly, to the great advantage of their mental as well as their financial state; the company is saved the expense of maintaining them on a disability-compensation schedule, and, at the same time, paying for a permanent force in the salvage department; and, lastly, when the convalescents "graduate" from the salvage department to resume underground duties, they are in better condition than they were formerly when, on termination of hospitalization or convalescence, they were obliged to return direct to their regular duties or become idle.

In final analysis, the scheme represents a solution of a problem prevailing in many industries, and one chiefly psychological in character. Those of the mining industries who started their careers at the bottom of the ladder as underground workers, and who, in consequence of illness or injury, were compelled to "lay off" for awhile, and then return in a weakened condition to heavy work, will appreciate the humanitarianism of the plan. Others, who have had a "hitch" in the Army, and who are familiar with duty, light duty, and "quarters," will see in it the establishment of "light duty" in the industrial world. The plan is a praiseworthy and humane development, with attendant economic advantages. With these recommendations to commend it, no delay should occur in its general adoption in the mining industries.

The Beneficiaries of Lady Luck

THE year just passed has been kind to investors: those who bought a representative list of sound "industrial" stocks at the end of 1926 would have found that their value had appreciated by about 29 per cent at the end of 1927, and the buyer of railroad securities would have been about 17 per cent better off. January is a good time not only to make plans for the coming year, but to look back and see what one might have done in the year just passed had one been gifted with better judgment or second sight. What, for instance, was the outstanding buy in mining stocks at the end of 1926, in the light of values a year later? Many mining stocks have received a great deal of publicity in the financial papers owing to a marked advance in their quotations: American Smelting, Greene Cananea, Freeport Texas, International Nickel, and several others immediately come to mind. But of the 177 mining stocks quoted by *Engineering and Mining Journal,* maximum profit would have been secured in none of these. In fact, many of the most profitable speculations of a year ago were in the lesser-known stocks, the shares of the big companies indicating a greater degree of stability.

An increase in value of over 600 per cent in one year should satisfy the most avaricious, and this is exactly what Arcadian Consolidated, up in Michigan, attained, rising from 45c. a share to $\$3\frac{3}{16}$. For several years the company has been carrying on exploration work in the Arcadian and New Baltic lodes, assessments paying the cost of the work. Only in the last year have attractive orebodies been found. Second prize for good luck must be awarded to the shareholders of another small company, the North Lily, an Anaconda subsidiary, whose shares appreciated a modest 450 per cent, from 70c. to $3.75. In the same Tintic district, where Tintic Standard was doing such exciting things two or three years ago, Eureka Lily was kind to its stockholders in 1927, its shares rising from 33c. to about $1.50; and not far off, in the Big Cottonwood district, near Alta, is the Cardiff Mining & Milling Company, recently quoted at 96c. a share, compared with 23c. a year before. Utah mining is evidently looking up. Fifth in the list of money-makers, and the only one quoted on the New York Stock Exchange, is Greene Cananea, which, by reason of the discovery of a large body of high-grade copper ore, advanced from $33 to $143 in the interval under consideration. It is interesting to observe that none of the twenty or more Canadian stocks quoted have appreciated to the extent of those named, though many were the subject of much ballyhoo on the part of interested brokers and achieved a considerable amount of favorable development.

Perhaps one should not speak of disagreeable things here, but it may be of interest to mention that those who bought and held North Butte, Gladstone Mountain, Vipond Consolidated, Tonopah Belmont, Keeley, and Erupción, a year ago, showed the worst judgment, losing more than half of their money in the course of the year, without considering dividends. But fifteen mining companies more than doubled their share prices, so the balance is well on the right side. In addition to the five companies mentioned in the preceding paragraph, honorable mention should be given to Kirkland Lake, Beaver Consolidated, Sunshine, Consolidated Coppermines, International Nickel, Teck-Hughes, Consolidated Cortez, Yukon Gold, Iron King, and Freeport Texas.

Speculators have a good field to pick from in 1928. There is more high-grade ore in the ground than has ever been taken out; the question is, who will find it?

Progress in Flotation, and the Metal Markets

SPEAKING before the Mining and Metallurgical Society of America recently on the subject of lead, Mr. J. R. Finlay emphasized the fact that the outlook was greatly improved because "selective flotation had shot its bolt." Mr. L. Vogelstein, of the American Metal Company, said frankly that selective flotation had been "the curse of the metal markets" in the last few years. The inference of Mr. Finlay and the plain statement of Mr. Vogelstein that selective flotation had been anything but a blessing to the mining industry deserve some explanation.

That the comparatively sudden incidence of a technical process so important and revolutionary as selective flotation would have far-reaching results and necessitate some readjustment in the economic position was to be expected. That, in the process of readjustment, the mining industry might suffer should not occasion surprise.

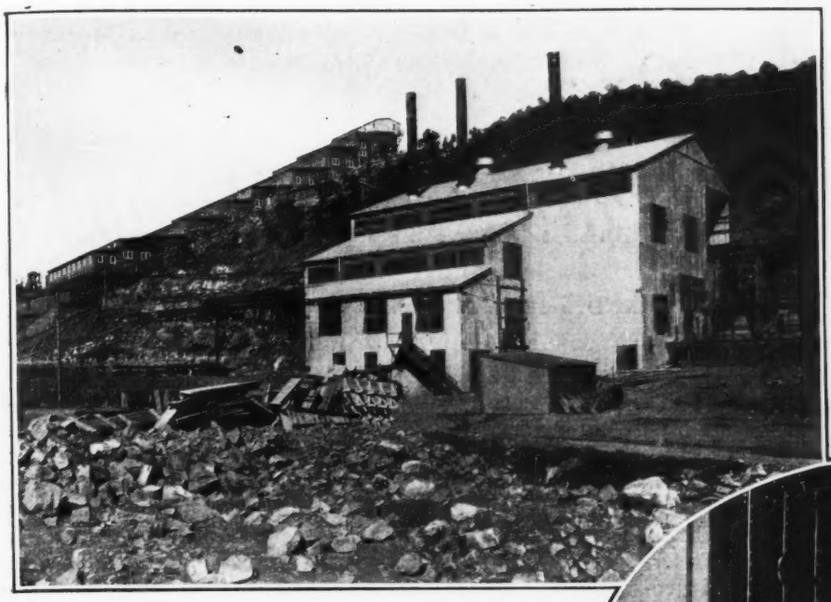
Selective flotation was responsible for a great increase in metal production, quite apart from the opening of new mines. It was not even necessary to build new plants, generally speaking. With minor remodeling, with some rearrangement of flow sheets and the introduction of new reagents, the same equipment acquired a capacity for producing 10 to 25 per cent more metal. Unquestionably, the resulting rush of new copper, lead and zinc became a factor in the metal markets. It had the effect of depressing prices.

The extent to which various companies suffered is inversely proportional to the advantage they derived in their own operations as a consequence of lowered production costs attained by the use of better flotation practice. But, as Mr. Finlay points out, the ill effects of selective flotation, particularly with respect to lead, have about run their course. He reasons that in old operations, where opportunity existed, output already has been increased, and that the expanded production rate has, in effect, been absorbed.

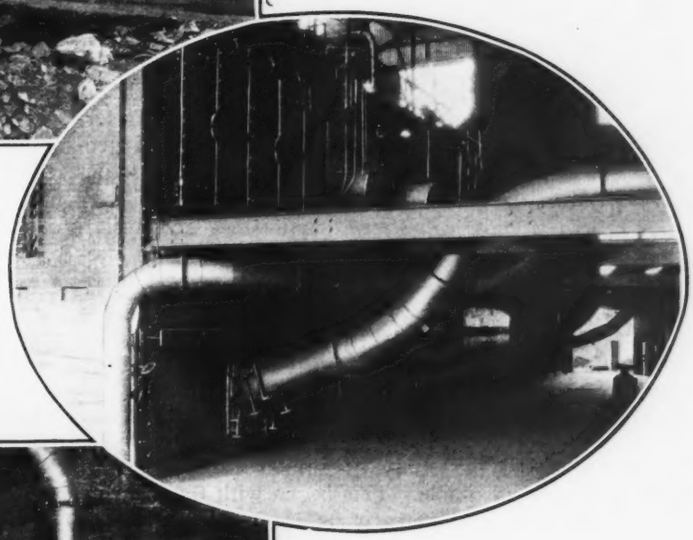
On the other hand, the unquestioned benefits of selective flotation have been great and permanent. Many mines in the same position as the Sullivan, in British Columbia, owe their economic existence to the process. It has increased measurably the world's available supply of copper, lead, zinc and other metals; or, stated otherwise, it has reduced the price that industry must pay for its supply of metals. It has not, of course, caused metal to grow where none was before; but, by lowering the cost of winning metal from a given deposit of ore, it has lowered the price level at which a balance between requirement and supply will be reached.

Unfortunately, the mining companies that financed the research and employed the technicians who evolved the new methods are not likely to get a fair share of the benefits. Industry, the manufacturer, society at large—these will be the real gainers. Again, the question crops up: should not a way be provided to permit legitimate co-operation in marketing, so that the producer of raw materials may win a reasonable return on the capital he has invested, and share the reward of technical and economic progress achieved solely through his own efforts?

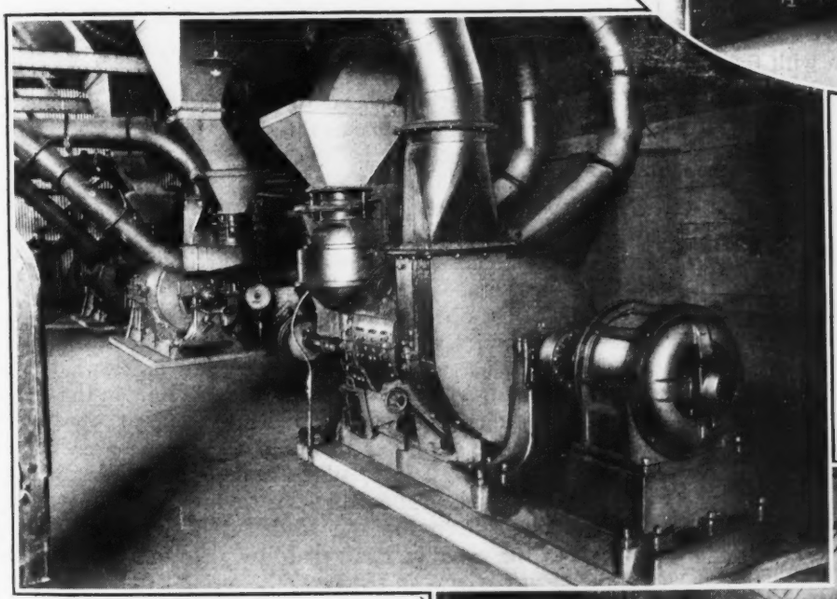
An Up-to-date Plant for Burning Powered Coal at a New Mexico Mine



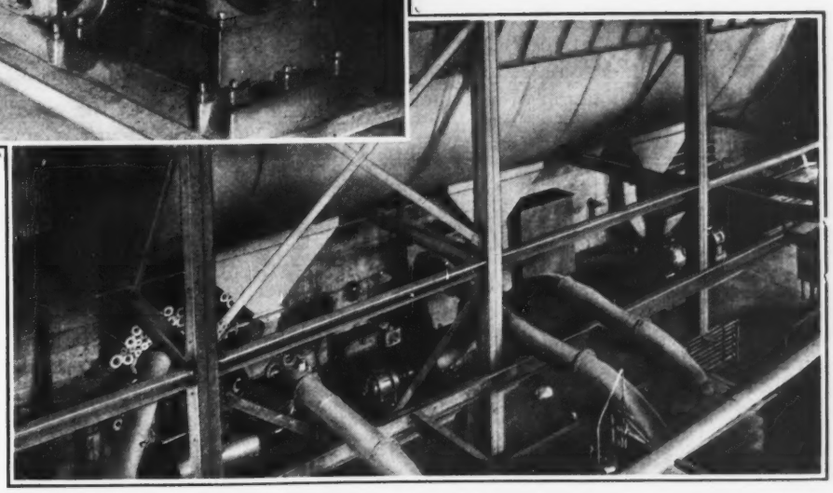
Left—Exterior view of plant.



Right—Boiler room of American Metal Co. at Glorieta, showing 346-hp. Springfield boilers with pulverized-coal duct entering furnace at center and preheated air ducts from air-cooled furnace walls carrying hot air to the coal pulverizers.



Left — Three Aero pulverizers used at the Glorieta plant. The orderliness and accessibility of this boiler room are evident from the pictures.



Right—Looking down on the pulverizers at the Pecos Mines plant. The fuel storage hopper is shown above the pulverizers; also the preheated air pipes from the boiler settings and pulverized coal ducts to the furnaces.

*Exploring for Ore by Potential Methods**

BY E. G. LEONARDON AND SHERWIN F. KELLY
Schlumberger Electrical Prospecting Methods, New York

THE QUESTION of geophysical prospecting is one that is beginning to occupy a pre-eminent place in the minds of those actively concerned in the discovery and exploitation of ore deposits. This is in marked contrast to the reception accorded such ideas when the junior author, six and a half years ago, began introducing electrical prospecting to the mining fraternity on this continent. Happily, the mention of geophysics no longer evokes the skeptical and pitying smiles that it did in those days.

A little reflection will show that modern geophysical methods are merely a logical development from pre-existing techniques. In the study of geological problems, is it not logical to use all possible physical properties of matter? The study of crystal form and cleavage and the examination of thin sections of minerals by means of polarized light or ordinary light, in fact, utilize physical properties for the benefit of the geologist. These are, of course, laboratory methods, and the extension of the study of similar properties into field work was inevitable. This began with the magnetometric surveys, used as early as 1760 in New Jersey to locate iron ores. John Locke's work in the United States, 84 years later, resulted in pointing out relationships between the terrestrial magnetic field and main tectonic features of the earth's crust.

In 1887 the study of a second kind of field of force came into practical use: the gravitational. This was a result of the development of the torsion balance by Baron von Eötvös, professor of physics at the University of Budapest. He introduced certain modifications into the Coulomb torsion balance, used for laboratory work since the eighteenth century, and made it adaptable to studies in the field. This instrument measures, with great sensitiveness, very minute differences in the strength and direction of the gravitational field. These factors of the field are directly affected by the densities of underlying formations.

The practical utilization of yet another physical property, that of electrical conductivity, was made possible in 1912 by the studies of Conrad Schlumberger, professor of physics in the School of Mines of Paris. At about the same time, Lundberg and Nathorst were conducting similar experiments in Sweden, and Harry Conklin, in Missouri, was working on the problem.

It is almost obvious that the pursuit of this line of investigation would lead to a tremendously wide application in the domain of geophysics, because there is probably no other physical property of geological formations which varies within such wide limits as does the electrical conductivity. A few examples will serve to illustrate the point.

The densities of rocks and minerals lie between 2 and 8, so that the maximum ratio between formations likely to be encountered in gravimetric studies will be of the order of 1 to 4, and will usually average much less than 4. This is in marked contrast to the ratios between conductivities. The conductivity of a piece of ore like pyrite or galena is commonly of the order of 5,000 mhos per meter cubed, whereas for the ordinary country rocks it is in the neighborhood of 0.001 to 0.004 mhos per meter cubed. This makes a ratio of the high magnitude of 1,000,000 or more!

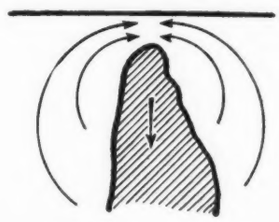


Fig. 1—A body of pyrite and its inclosing rocks constitutes a huge natural battery. The current flows, as indicated here

Even when it is not a question of the differentiation of rock from ore, but of rock from rock, this can be done very frequently by electrical measurements. It is possible because the ratio of conductivities between clays and sandstones or other compact rocks, for instance, is often of the order of 100 to 200.

No wonder, then, that the potential methods have found such a wide field of utility and application and have been used so successfully for some time in the solution of difficult geological problems.

To attempt to cover this field adequately, even in its larger outlines, is impossible in one paper. This article will have to be confined, then, to the subject of more particular interest to the reader—namely, the application of the potential methods to the detection of ore, and the services they can render to the metallic mines.

The preceding discussion has emphasized the importance of the marked differences in conductivities between rocks and ores, and has introduced the concept of a method capable of utilizing comparisons thereof in actual practice. The use of an outside source of current for creating a field of force in the earth permits the discovery of many minerals to be made through the study of the distortion of the potential fields.

Before describing and developing that point, however, it would be well to take up the use of a very simple electro-chemical phenomenon, one which is of general occurrence. It provides the basis for a supplementary

*This paper was presented at the annual general meeting of the British Columbia Division of the Canadian Institute of Mining and Metallurgy, held in Vancouver, B. C., Nov. 24, 1927. It is published also in the January issue of *The Canadian Mining and Metallurgical Bulletin.*

method of electrical prospecting, notable for its simplicity and rapidity of operation.

A few theoretical points must be insisted upon here, so that it will be more readily seen that what follows rests upon a sound basis.

There are two sorts of electric conductivity, "metallic" and "electrolytic." Metallic conductivity is possessed by the metals, and some of the ore minerals, such as pyrite, chalcopyrite, galena, arsenopyrite, magnetite, pyrolusite, graphite, and certain anthracites. In general, minerals having a metallic lustre also have metallic conductivity. The other materials are, comparatively speaking, non-conductors. Particularly is this true for the carbonates, silicates, most of the oxides, and, among the sulphides, sphalerite and stibnite.

When a current is transmitted by a metallic conductor there is *no* transport of ions.

Electrolytic conductivity is possessed by electrolytes —solutions, usually aqueous, of dissociable salts, and wherein the transmission of current is *by transport* of ions. Rocks are non-conductors themselves, but as they always contain a certain amount of moisture, at least adsorbed, they become electrolytic conductors.[1]

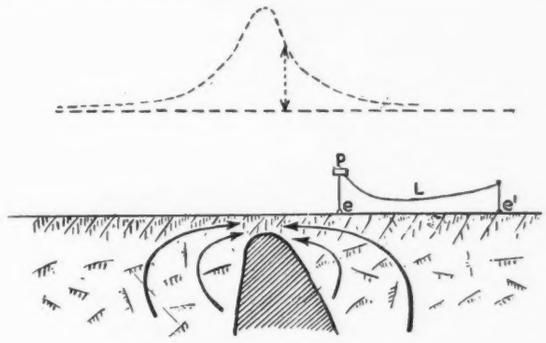


Fig. 2—An ideal profile of potentials or curve obtained by plotting the differences of potential determined on the surface above an orebody

Clays and limestones are good conductors, on this account, whereas granites and metamorphic rocks are more resistant because they contain but little water, and it is poor in mineral salts.

When a metallic body is plunged in an electrolyte, and there is a dissymmetry of any kind, either in the metal or the solution, a current is generated which flows in such a way as to reduce the dissymmetry giving it birth. A battery is thus formed.

A lens of pyrite in inclosing country rock is the equivalent of a homogeneous metal plunged in a dissymmetrical electrolyte, and forms a battery. This action is due to the fact that the moisture present in the inclosing rocks does not everywhere have the same composition. Near the surface it is aërated and, in consequence, rich in oxygen, whereas at great depth this is not so, for there is no opportunity for replenishment of the oxygen supply. Thus it is that the body of pyrite and its inclosing rocks constitute a huge natural battery. The current flows, as is indicated in Fig. 1, down the metallic body, out into the wall rocks, and up to the apex. At and near

[1]Incidentally, it may be noted here that all rocks possess more or less electrolytic conductivity and consequently no formation is non-conductive. A statement affirming that arid areas cannot be studied electrically because the current could not flow in dry (insulating) formations is entirely false. The intensity of the current varies, of course, with the moisture content; so for purposes of observation it is only a question of the sensitiveness of the instruments used.

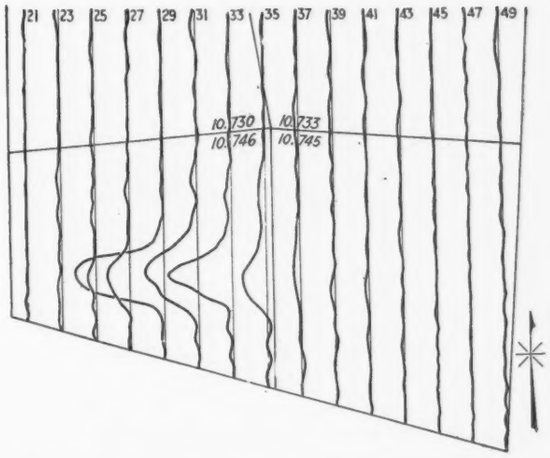


Fig. 3—A sample of reconnaissance work. When no electrical conductivity is recorded the profiles of potentials show only flat wavy lines. The presence of an electric element underground, such as an orebody, will cause a high peak

the surface of the ground the current flows back into the body, thus completing the circuit. Owing to the consequent electrolytic action, hydrogen is liberated at the cathode near the surface, and oxygen at the anode, or deeper parts of the mass. The gases so formed do not escape, but the nascent hydrogen combines with dissolved oxygen to form water, and the oxygen liberated at depth dissolves in the moisture of the inclosing rocks. Thus, the whole process works towards an equalizing of the distribution of oxygen within the earth's crust and provides a means for diffusing that element to great depths.

If the metallic substance is an oxidizable one, as is pyrite, this battery effect is considerably strengthened, thanks to the chemical energy released by the processes of atmospheric oxidation. That is, the oxidized gossan provides a depolarizer, exactly analogous to the manganese dioxide used for this purpose in a dry cell. The hematite and limonite favor the absorption of the hydrogen, and give it a substance to reduce. Lower down, the oxygen, instead of diffusing through the surrounding

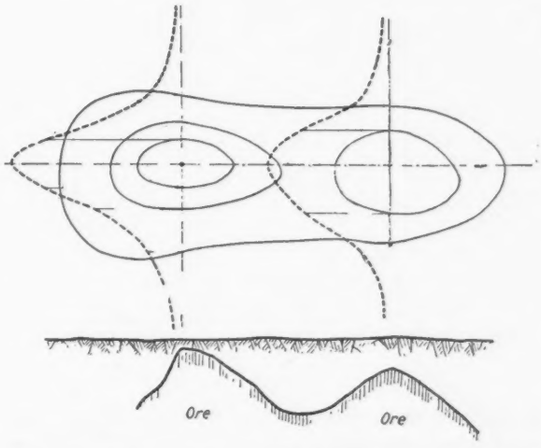


Fig. 4—The work begun by measuring profiles is completed by tracing equipotential curves. Each such curve joins all points of the surface that are at a given electrical potential

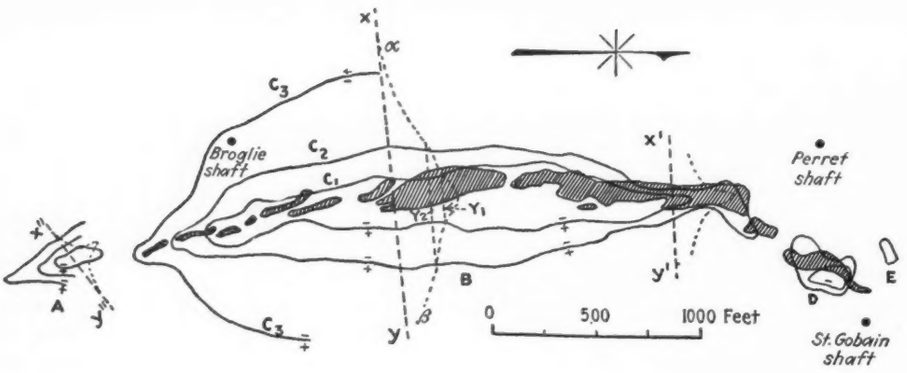


Fig. 5—A map representing the field work done on the pyrite deposit of Sain Bel, France. The shaded areas indicate ore at depth of 350 ft.

formations, attacks the sulphide. Thus the original dissymmetry of the electrolyte is maintained in a fashion that would not be the case were the mineral not oxidizable. Slow diffusion would not be sufficient to prevent the action becoming weaker with time.

In effect, then, the electric current, generated as explained, tends to carry to the deeper parts of the metallic mass the oxidizing action that takes place at the surface and that is due to atmospheric agencies.

The Surface Phenomenon

What, then, is the phenomenon observable at the surface of the ground, where all exploration must begin? The phenomenon is a flow of current, converging on a point over the apex of an orebody, and giving rise to a drop of potential in the ground. If a distant point be taken as zero, then a strong negative value will be noted over the sulphide body. Fig. 2 shows these values plotted on a curve, known as the "profile of potentials." The point into which the current flow is concentrated is called the "negative center."

To make the readings necessary to record these values, the following procedure is used. The current in the ground is shunted through a potentiometer by means of two electrodes, in contact with the soil at two different places, connected by an insulated wire with the potentiometer. Fig. 2 illustrates the apparatus diagrammatically. This potentiometer permits the operator to

1. See if there is a difference of potential between the points touched by the two electrodes.
2. Note the sign of this difference—that is, the direction in which the current is flowing.
3. Measure the strength of this potential difference.

From what has been said it will be observed that, for an orebody to show "self-potential," it must possess metallic conductivity throughout a certain height. This requires that it be made up of minerals having metallic conductivity, and that these be in sufficient concentration to provide a continuous metallic path for the current.

All bodies of common sulphide minerals (except pure sphalerite, stibnite, and cinnabar) whose apexes come near the surface show a spontaneous generation of electric current. A mixture of other minerals with the conducting sulphides (such as sphalerite mixed with galena and pyrite) does not prevent such a current from being generated, and thus ordinarily inert minerals can be located electrically.

Copper sulphides are, of course, conductors, and oxidizable, and usually remarkably continuous. They are thus extremely well adapted to electrical methods of detection.

Determining Continuity of Mineralization

The continuity of mineralization is not a thing that can be judged by optical examination. Frequently it will happen that a specimen of sulphide ore will seem to present, to the naked eye, an excellent example of discontinuous mineralization providing too poor a path for the electric current to flow, and hence of a type not detectable electrically. Yet a laboratory test reveals that it is an excellent conductor! This is due to the fact that, in many cases, the sulphide mineralization has penetrated fine cracks and fissures, and ramifies through the gangue rock in tiny, interlacing fingers and stringers. These, touching and intersecting, provide the necessary metallic continuity. Particularly is this the case with the copper sulphides. For this reason, no type of sulphide mineralization should be classed as hopeless from the point of view of electrical prospecting, without first being subjected to a laboratory test.

The Field Work

The field work consists, first, in a methodical exploration of the area being prospected, to find those regions, showing "self-potential." This is done by taking readings of potential differences at given intervals along straight, parallel lines at a certain distance apart. The regions showing self-potential are then studied in detail, and the

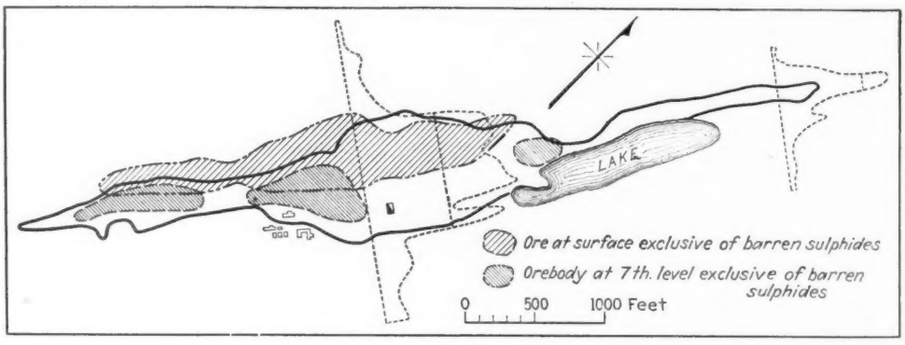


Fig. 6 — A map showing results of work done at the Frood mine of the International Nickel Company at Sudbury, Ont. The ore at surface and at 700 ft. is shown by the differently shaded areas

results plotted on appropriate maps. These enable the operator to give the outlines of sulphide masses, their length and breadth, and the approximate depth to their apexes.

The differences of potential occurring along a given line are generally plotted in graphic form, giving what are known as "profiles of potentials." When no electrical activity is recorded they show only flat wavy lines. On the contrary, when there is an orebody forming an electric element underground, a high peak is observed, more or less acute, according to the thickness of the overburden. Fig. 3 illustrates this type of reconnaissance work. This work, begun by measuring profiles, is completed by tracing equipotential curves. Each such curve joins all points of the surface that are at a given electrical potential. They inclose the negative center and conform roughly to the horizontal projection of the orebody. They may

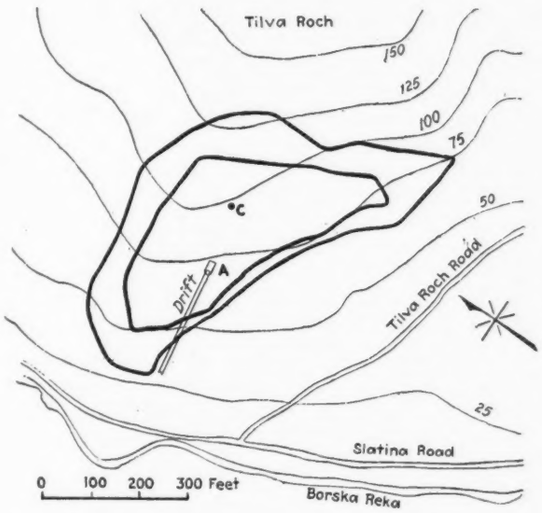


Fig. 7—Electrical results obtained at Tilva Roch, near Bor, in Serbia, are shown on this map

be pictured as the "contour lines" of the mountain of electrical activity which is centered on the orebody (Fig. 4). This may best be illustrated by giving some practical examples from our field work.

Fig. 5 represents the work carried out on the pyrite deposit of Sain Bel, in France. The shaded areas indicate ore at a depth of 350 ft. The equipotential curves outline the region of mineralization quite accurately. Three profiles of potentials are shown in dotted lines, each rising to a peak over the ore. At the south end of the area an isolated negative center was located at *A*. Later exploration work discovered here a fine lens of pyrite.

These Phenomena Show Permanence

Regarding the permanence of these electrical phenomena, it may be stated that a survey at Sain Bel in 1921 found exactly the same results as the survey conducted in 1913.

The next figure (Fig. 6) illustrates one of the earliest pieces of work done on this continent (in 1921). It shows the results of work at the Frood mine of the International Nickel Company, near Sudbury, Ont. The mineralization is massive, consisting of pyrrhotite, pyrite, pentlandite, and chalcopyrite.

The ore at surface and at 700 ft. is shown by the differently shaded areas. An equipotential curve outlines satisfactorily the mineralization, though it apparently takes in a much larger area than is warranted by the indicated ore. An important point is to be noted in this connection: no form of geophysical prospecting can distinguish the ore minerals from each other; predominantly pyritic masses are not separable, therefore, from other metallic sulphides.

The areas shaded show only those places high enough in nickel to make a nickel ore, whereas practically the entire area within the equipotential curve is heavily mineralized with sulphides.

Fig. 7 gives the electrical results obtained at Tilva Roch, near Bor, in Serbia. The negative center is at *C* and two equipotential curves are traced around it. Tilva Roch is an andesite hill a quarter of a mile from the well-known copper deposit of Bor, one of the biggest copper mines in Europe. Prior to the electrical work no indication of mineralization had been found in this area. A drill hole subsequently put down at *A* penetrated a copper deposit at a depth of 40 ft. and remained in it to a depth of 280 ft. The copper content averaged 2.8 per cent.

Some Practical Points

This exposition of the self-potential method will be terminated by the consideration of several practical points, which are of the greatest importance, although they have not always been given their proper value by many experienced geophysicists.

1. Every orebody composed of conductive metallic sulphides, and which acts as a metallic conductor *en masse*, gives rise to spontaneously generated currents. In fifteen years' work in the field we can state that we have not yet observed any conductive orebody which does not present this phenomenon more or less. Of course, the observations must be made with great delicacy, and the geophysicist need not hope to detect differences of potential of a quarter of a volt in every case. This would be too much to expect of Nature.

If the mineral is conductive and the mass of the body is not, the method will not work; but in that case a serious doubt may be entertained as to the applicability of any other electrical method claiming to locate orebodies. As far as is known no precise results of experiments on this type of deposit have so far been made public.

2. Another point is that of the depth to which exploration can be carried. Analyses of underground waters prove that oxygen penetrates to great depths in the earth's crust. Mining work shows also that oxidation of orebodies, which is connected with the self-potential phenomenon, is not confined to a shallow slice of ground near the surface. Finally, the results obtained in the field at depths of 300 and 400 ft. are generally excellent. For instance, the strikingly clear results observed in Sain Bel, which are represented on Fig. 5, refer to an orebody the top of which is more than 300 ft. distant from the surface.

The facts recorded prove abundantly the possibilities of the self-potential method at depths. There are, of course, as in any prospecting process, certain limitations which depend principally on the electrical activity of the sulphides and on the form and dimensions of the orebodies.

To be concluded

Rubber in the Mining Industry

An Editorial Study

APART from its use in the automotive industry, rubber in various manufactured forms finds numerous applications in other industries and in everyday life. It is an indispensable raw material, and for certain purposes there is no effective substitute, but, like other raw materials and metals, competition and energetic technical research, together with well organized manufacturing and sales distribution, determine the extent to which it will be used. An additional factor is the publicity given to new forms and compounds of rubber and newer applications. This article reviews the present situation with reference to the mining industry.

One of the significant properties of rubber is its resistance to abrasion or wear, especially if lubricated. A comparatively thin sheet of soft rubber will resist abrasion, but thickness or mass is necessary to insure resistance to impact as well. Rubber does not resist cutting, so it is necessary to investigate fully the nature of the material that comes in contact with it and the kind of forces that are at play. The use of rubber liners for tube and ball mills and other grinding mills exemplifies a kind of service in which abrasion plays the most important part, but also in which impact must be considered. Pioneer efforts in developing a rubber liner for grinding mills offered promise, and eventually a liner was developed that has withstood hard service. One type has a composite structure, the wearing surface being of soft rubber varying from a minimum of one inch to a maximum of two inches in thickness. A steel insert rib to which the rubber is vulcanized affords a means for attachment to the shell by bolts and gives sufficient rigidity. The unit is 16 in. wide by 5 ft. long. The width is variable to accord with different diameters. A definite composition has been worked out for the two kinds of rubber used in the unit. Comparative weights for a 5x22-ft. tube mill are 2.1 tons for rubber liners and 14 tons for steel liners of 2-in. average thickness. The weight ratio upon an equal thickness basis is six for steel to one for rubber, and upon an equal wear basis, about ten to one. Other advantages apart from weight are greater ease and rapidity in replacement. The selection of material for liners and for balls is based on comparative costs in any given case, plus an appraisal of advantages that might arise from the use of a given material. It is obvious that the fewer the replacements the greater will be the uninterrupted service of a grinding unit. It is, therefore, an important economic factor in mill operation to select machines that will be dependable over long operating periods and also to equip machines so that operating time will not be seriously diminished by replacements of worn-out parts. Conservatism, as well as local factors, has limited the application of rubber liners in grinding service, but their use may be expected to broaden.

LAUNDERS have occupied the attention of millmen, and a good launder lining has been assiduously sought. Rubber has been found to be of service for this purpose. Plain sheet rubber (without fabric), vulcanized and ¼ in. or more in thickness is supplied to the market for launder lining. In some places in the Far East, crude crepe rubber has been used. Sheet rubber, with one or two plies of fabric for stiffening purposes, is also supplied, as well as with any thickness up to 24-gage metal backing with the rubber vulcanized thereto. The metal may be steel, aluminum, or brass. The metal backing gives stiffness and is an advantage in shaping the launder. Probably the first use of rubber-lined launders was by the gold-dredge operator who cut up his worn-out conveyor belts and used them to protect the metal tailraces. The millman generally used wood, and where coarse products were handled, lined the launder with wooden blocks on end. Metal liners as well as quartzite blocks were also used where large tonnages were to be handled. Rubber offers a more convenient material both with respect to weight and to its wear-resisting qualities. As with grinding-mill liners, comparative costs and life determine the most economic material for a given situation.

Another application is for chute lining, where it is necessary to receive the discharge of crushers, screens, and revolving trommels. In this instance impact, as well as abrasion, plays a part. Where ¼-in. thickness of rubber will answer for the finer sizes, 1½ to 2 in. is necessary for coarser sizes up to 1½-in. ore particle. For still coarser sizes rubber does not answer so well as metal liners. A thick rubber lining is being used on the inside chutes of Symons crushers. Upon screen discharges it is said that ½ to ¾-in. rubber liners will outlast a similar thickness of steel from seven to eight times.

Rubber-lined pipe in which the lining consists of a high-grade compound (without fabric) vulcanized to the pipe is now available and should find application in place of metal pipe used for runs from distributors to tables and other ore-dressing machinery. The rubber lining has an adhesion as high as 600 to 700 lb. per square inch and is beaded out at flanges so as to make a complete lining at fittings. At one large flotation plant rubber-lined pipe is being used upon the discharges of the sand pumps and is giving two or three times the service of extra heavy steel pipes.

IN FLOTATION work, rubber runners have been used in acid circuits and have given good service. In alkaline circuits, runners are made with a coating of pure gum vulcanized upon cast iron, and give longer service than all-metal runners. Pump runners for centrifugal pumps are also rubber incased, as is the pump casing. Likewise, rubber-lined pipe has been used to advantage upon the discharge from centrifugal pumps handling flotation pulp. An example is known where 1,000,000 tons of flotation feed (9 per cent on 65 mesh) has been handled without appreciable wear upon the rubber-incased runners of the flotation machines and upon the rubber cell lining. Riffles in the K. & K. flotation machine are made of soft rubber, and rubber mats constructed of woven or of perforated rubber are being experimented with in pneumatic flotation cells. Rubber

lining in flotation cells is another application which offers promise of considerable use. All flotation pulps are not necessarily abrasive, but where they are, rubber offers the opportunity of improving the wear-resisting qualities of the flotation machine and especially of the machines in which mechanical agitation is a feature.

Tops for concentrating tables have been constructed of wear-resisting rubber and have given long service. Semi-hard rubber riffles have also been made and used. Vanner belting represents one of the earliest applications of rubber in milling service.

Diaphragms for slime pumps used in cyanide and flotation plants are made of a good grade of rubber so as to give the maximum number of flexures. Fabric is not used in rubber where it is to be used for this purpose.

RUBBER belting for conveyor, elevator and transmission service has been accepted practice for many years. Conveyor belts are now built both in fabric and in rubber compositions to meet particular service conditions and are often sold upon a basis of service to be expected. For heavy loads and highly abrasive materials such as sand and gravel, high-grade rubber is necessary. In gold-dredging work sufficient body and a good cover stock are necessary to resist both impact and abrasion. Ore conveying requires high-grade stock compounded especially for the purpose and of a tensile strength of upward of 4,000 lb. per square inch. Service is built into the belt at increased cost and as a consequence the largest part of the purchase price is in cover stock. Thickness of cover stock is determined by the load to be carried, the distance and feed and discharge conditions. This cover stock is $\frac{1}{8}$ in. or more in thickness and underneath is an "open-mesh" fabric or "tie gum," which is woven cotton fabric of $\frac{1}{8}$-in. openings having for its purpose the "riveting" of the top cover to the carcass of the belt. Thus resistance is offered to the elongation of the gum cover, which will not tear off in strips, with this construction, when the belt becomes snagged.

An important development in rubber belt-conveying practice is seen in the duplex system, whereby a comparatively thin wear-sheet rubber belt rides on a transmission belt of appropriate strength. All the strain is taken by the transmission belt, which is taut, and all the abrasion by the wear-sheet belt, which is slack and easily replaceable.

UNDER some conditions conveyor belt is being used to replace traveling grizzlies and steel apron plate feeders. For such service a cover stock of $\frac{1}{4}$ in. in thickness is required. Conveyor belting is built with a sufficient number of plies of 28, 32, or 36-oz. duck to give the body of the belt the requisite strength. The designation of the cotton fabric is the weight in avoirdupois ounces of a piece of fabric 36x42 in. in size.

When it has outlived its usefulness in the original installation, rubber conveyor belting can often be cut up and used for stair treads and miscellaneous purposes.

Good ply adhesion is essential under some conditions, and this can be controlled by the belt manufacturer. Friction or ply adhesion varies from 2 or 3 lb. up to 38 to 40 lb. per square inch. To enhance ply adhesion requires different grades of gum and its application to the cotton under different conditions.

Belts for bucket elevators require greater tensile strength than ordinary conveyor belting. The cover is a high-grade stock, because of slippage and abrasion at the head pulley. Here also an open mesh fabric is considered a necessary part of the belt construction.

Power-transmission belting scarcely needs comment, for it has been used in milling plants for many years. With the increase in geared speed reducers and individual motor drives there has been a considerable reduction in the number of belt drives in the modern mill, but, in spite of this, it is said that the quantity of rubber belting manufactured for power transmission is probably greater than formerly. This is because industrial operations have been enlarged at a faster rate than the rate at which belting has been eliminated by geared appliances and individual motors.

Gears and speed reducers offer an efficient means of speed reduction and power transmission, but the V-belt constructed of rubber and cotton fabric is now successfully competing. V-belts are used satisfactorily for rock-crusher, ball-mill, tube-mill, bucket-elevator, and conveyor-belt drives on short centers. The V-belt is endless and the possibility of stretch is obviated in the process of manufacture. The sides of the belt transmit the power, and as a consequence a 1-in. belt has two inches of transmission surface. Many new applications are being made of the V-belt drive, as it gives a cheaper and quieter drive than gears. The life of V-belting has not been accurately determined, as it has been in use for only one and a half years.

Another improvement in ordinary rubber transmission belt is the endless belt, which hitherto was made by cementing the ends of a belt together. Now the process of manufacture has been greatly improved, and a belt in which the fabric plies, as well as the cover stock, are continuous and uniform over the length of the closed belt can be obtained. Necessarily such belts have to be made to special order.

THE fact that water acts as a lubricant of considerable efficiency when filmed upon a smooth rubber surface, as is evident to those whose rubber heels have slipped on a smooth wet pavement, has resulted in the development of the rubber bearing. A high-grade rubber composition is vulcanized to a brass or steel shell. Two or three helical grooves are cut into the rubber to permit the water used as the lubricant to move from end to end of the bearing. Another arrangement is a series of parallel grooves, or fluting, longitudinally placed. In using such bearings it is essential that the water must not carry oil, gasoline, or distillates, as all affect rubber. The first obvious point about the rubber bearing is the elimination of oil and grease lubricants and, therefore, a decrease in the fire risk. Rubber bearings can be used in bucket-elevator service, in sand pumps, water pumps, and in agitators, and generally where there is grit or slime in the solutions. One of the first uses of such bearings was in the Hendryx agitators, which were once used in all-slime cyanide plants. Undoubtedly the use of rubber bearings has advantages where abrasion shortens the life of ordinary bearings. In one instance their use in bucket elevators has given over two years of service where it was necessary to change metal bearings and boot pulley shafts every month.

INCREASE of hydrometallurgy, especially in copper and zinc, necessarily increases the importance of all corrosion-resisting materials. Lead in the form of pipes, valves and fittings is largely used, but weight is an objectionable feature. Rubber-lined pipe seems to be worthy of consideration. Rubber-lined valves in which the liner is renewable and in sizes from 1 to 6 in. are offered for acid and alkaline solutions. It is unnecessary to recall

the availability of hard rubber pipe, valves, and fittings, as these have been upon the market for a long time.

Rubber tank linings, attached to wood or steel, are used in flotation plants for the storage of reagents such as xanthate, sulphates, and sulphuric acid, to a greater or less extent replacing lead. In electrolytic zinc plants, hard rubber pipe, valves, and fittings are used. Rubber-lined air lifts and rubber-lined centrifugal pumps are also of service in handling corrosive solutions.

A new product in vulcanized semi-porous rubber, "Aeroboard," has recently been placed upon the market. It can be worked like wood and with the same tools. Its specific gravity is 0.4 to 0.5; tensile strength, 1,000 to 1,200 lb. per square inch; elongation, 1 to 3.5 per cent; compressive strength, 1,000 to 2,000 lb. per square inch; comparatively high dielectric strength; low conductivity, and moisture absorption, but softens at 120 to 140 deg. F. It is acid resistant and is used for making boxes for transporting and storing acids and alkalies. It is not suitable for abrasive conditions, but it may be used for making scrapers for cylindrical filters.

UNDERGROUND, rubber finds application for miners' boots, shoes, and clothing; drill hose; gaskets; rubber-lined pipe for handling acid waters; belting for driving ventilating fans; and valves for plunger pumps. For the last-named purpose the rubber composition is varied to suit individual conditions. Most operators purchase a high-grade air hose, as such hose has a better oil-resisting tube. Hose of lower grade is used for suctions. Rubber-covered fire hose is used in preference to cotton. A greater and greater use is being made of large-diameter air hose, 2 to 3 in., which is used for long runs and terminates in a manifold from which short lengths of $\frac{3}{4}$-in. hose extend to the air drills. In open-pit and glory-hole quarrying large-diameter air hose affords a more convenient method than by pipes of supplying compressed air to the drills. Apparently only a relatively small amount of 1-in. air hose is being used. Water hose for drills, $\frac{1}{2}$-in. diameter, is usually of good grade as it has to withstand high pressures. Individual conditions determine the particular kinds. Another use of rubber is in placer mining, for which a porous sponge rubber for lining sluices has been placed upon the market.

HARDLY any phase of mining and metallurgy, from laboratory to mine and metallurgical plant, can be examined without finding the application of rubber in some of its numerous forms. The technology of rubber has made rapid strides, and rubber manufacturers can now meet a large range in conditions by selecting and compounding to give a product that will meet the conditions of service. In improving their methods of manufacture, it might well be mentioned here that products of the mining industry have played an important part; the use of sulphur, zinc oxide, and carbon black are well known, and selenium has interesting possibilities. Competition has been so keen that rubber manufacturers are upon their toes both to extend applications of rubber in industry and at the same time to make their goods suit conditions and give service that can compare favorably with other materials for which rubber is offered.

New Mount Elliott Electrolytic Copper Plant

By Henry S. Mackay
Metallurgical Engineer, Los Angeles, Calif.

IN THE Cloncurry district in Australia the Mount Elliott company is completing the first unit of a plant which eventually will be extended to produce 10,000 tons of electrolytic copper per annum. The present plant consists of five sections—namely, crushing, roasting, leaching, electrolytic deposition, and power plant. These sections are so designed and situated that each section can be extended to larger capacity without changing any of the present plant.

The crushing plant consists of a rock crusher, two sets of high-speed rolls, one ball mill, one Sturtevant screen separator, and two bucket-belt elevators, the whole plant being operated with one 50 hp. electric motor.

The roasting plant consists of one Mackay modified Wedge furnace 20 ft. inside diameter, with seven roasting hearths and one drying hearth. In this plant the furnace is connected to one Wilson pressure type gas producer with a capacity of 560 cu.m. of gas per hour. This producer uses coal, and delivers the gas to the roasting furnace at a pressure of 90 mm., to be used as fuel to roast the ore. The furnace plant is inclosed in a steel building 36 by 36 ft., and 40 ft. high. Ore will be delivered to the furnace in trucks which are raised from the ground level to the hoppers at the top of the furnace on an electric elevator with a capacity of one ton traveling at a speed of 100 f.p.m.

The leaching plant consists of two reinforced concrete tanks 30 by 60 ft., 10 ft. deep, lined inside with brickwork 4 in. thick laid in asphalt. These tanks have an inside leaching false bottom constructed of timber and broken stone. The roasted ore will be delivered to the leaching tanks and removed from the tanks after leaching by one Royce overhead electric crane which runs over rails 70 ft. apart at the ground level. The crane is supported on legs connecting the wheel base to the overhead crane which spans the tank. On top of the main trusses of the crane (73 ft. long) is a jib-crane grab with a capacity of 1 cu.yd. The main crane moves horizontally over the leaching tanks and the jib crane transversely, and is pivoted so as to operate round a complete circle. This crane has five motions, and each motion is controlled by a separate electric motor. It will unload and load the leaching tanks at the rate of 60 tons per hour.

In connection with the leaching plant there are four reinforced concrete solution storage tanks 30 ft. in diameter, and 10 ft. deep, lined with asphalt and sand composition. The leaching solutions are circulated by two Rees Roturbo pressure centrifugal pumps. That part of these pumps coming in contact with the copper and acid solutions is made of lead containing 5 per cent antimony. Each pump has a capacity of 160 g.p.m. All pipes for circulating solutions are made of lead.

The plant for the electrolytic deposition of copper from the leaching solutions consists of a two-story steel building 50 by 60 ft., and 43 ft. high. In this building on the second floor are 24 wooden tanks, 12 ft. long by 4 ft. 6 in. deep by 3 ft. 8 in. wide, lined with lead.

Each of these tanks forms three electrolytic cells and in each cell there are eleven lead anodes and ten copper cathodes. These tanks are connected in series and the electrodes in parallel. All busbars and the cathode and anode bars are insulated from the tanks and buildings by stoneware insulators. Over the electrolytic cells and spanning the building from side to side is one two-ton traveling electric crane which is operated from the floor level. This crane will place and replace the cathode copper to and from the cells. In the first or ground floor of this building there are three wooden solution circulating tanks 4 ft. 6 in. by 3 ft. deep, and 35 ft. long. These tanks are connected to four Rees Roturbo pressure centrifugal pumps; three of them circulate the solution through the electrolytic cells, and one circulates through the leaching section.

The power plant is 15 ft. from the electrolytic plant, and is housed in a steel building 30 by 60 ft., and 30 ft. high, with the boiler in a separate building 26 by 30 ft. This power plant consists of one Babcock and Wilcox boiler with 3,300 ft. of heating surface with superheater. The chimney to the boiler plant is made of steel and is 7 ft. in diameter and 120 ft. high. In the power house there is one Belliss & Morcom compound engine directly connected to one 400 kw. alternator delivering 220 volts, 3 phase, 50 cycles. This engine is driven with steam at a pressure of 160 lb. per square inch, superheated to 450 deg. F. The steam is condensed in a standard surface condensing plant, and the condensed water from this is delivered to a concrete reservoir 60 by 60 ft., and 5 ft. deep, and is used to make up leaching solutions.

In connection with the surface condensing plant there is a spray cooling plant. This consists of a concrete reservoir 60 by 60 ft., and 5 ft. deep with a series of spray pipes and nozzles operated from one electric centrifugal pump in the power station. This plant is designed to cool 30,000 gal. of water per hour. In the power house there is a motor generator set consisting of two open-type, shuntwound, direct-current generators directly connected to one 400 hp. a.c. motor, 220 volts, 3 phase, 50 cycles. These direct-current generators each deliver 2,500 amp. at 60 volts, and are connected on the switchboard so that they can be used for the electrolytic deposition of copper in the cell room separately or combined to give 5,000 and 60 volts. Motor pumps and lights in all sections of the plant are controlled from the switchboard in the power station. In the plant is one Ingersoll air compressor which will furnish the compressed air required for the plant.

Between the solution storage tanks and the electrolytic cell building there are two Pachuca tanks 5 ft. in diameter and 15 ft. high, made of steel and lined with lead. These tanks are used for purifying solutions before the solutions are electrolyzed, and are placed in a bypass of the solution circulating system between the solution tanks and the electrolytic cells.

In connection with the Pachuca tanks there is one Dorr thickener, 14 ft. in diameter, and one Oliver filter, for filtering the residue from the purifying system.

Facing the electrolytic building and about 200 ft. away is the chemical laboratory. This building is 50 ft. long and 25 ft. wide, is constructed of sun dried bricks and cemented on the outside and inside, and has a cement floor. This building is one story high and contains five rooms—a chemical room, scale room, furnace room, storeroom, and the superintendent's office. This plant was designed and all details were worked out by me in London, and the construction has been done under my personal supervision. The process used is briefly described as follows:

An ore mixture is made of sulphide and oxide ore in proportions required to form the acid necessary in the process. It is crushed to pass ¼-in. mesh screen, and then roasted in a furnace designed to control the chemistry of the roast so that the copper in the ore is converted from a sulphide to an oxide and sulphate, and the iron to an insoluble oxide. The ore is placed in the leaching tanks and (when starting the plant) is first leached with water. This water leach dissolves all the copper in the roasted ore that is in the form of sulphate. When the water leaching solutions are built up so that they carry 3 per cent copper, the solutions are purified to remove objectionable impurities, such as iron. They are then circulated through the electrolytic cells and the solution is decomposed by electrolysis. This deposits electrolytic copper on the cathode plates in the cells and free sulphuric acid in the solution. The acid solution formed is returned to the ore and dissolves all the copper in the form of an oxide. The operation is repeated continuously until all the copper is removed from the ore and deposited in the cells as electrolytic copper. When the copper is leached out of the ore the residues are removed by the crane, a new charge is added, and the process continued. The copper is shipped as electrolytic plates 3 by 2 ft. and ½ in. thick.

Metallurgical Plants Establish Creditable Record in 1926

A SLIGHT rise in the death rate and a small reduction in the injury rate were the main facts revealed by an examination of accident records covering the metallurgical industry (excluding steel mills) in the United States in 1926, according to the U. S. Bureau of Mines. The Bureau's examination of reports from operating companies revealed a fatality rate of 0.73 and an injury rate of 111 for each thousand persons employed, as compared with 0.66 and 116, respectively, for the year 1925. These accident rates are based on a standard of 300 working days per employee and include all accidents that disabled an employee beyond the day on which he was injured.

Accident reports are divided into three groups: those for ore-dressing plants; those for smelting plants (exclusive of the steel industry); and those for auxiliary works, including yards, shops, and construction work.

Men employed at ore-dressing plants in 1926 numbered 16,685; they worked 5,215,376 shifts, an average of 313 shifts per man. Thirteen men were killed by accidents and 2,294 men were injured, the fatality rate per thousand 300-day workers being 0.75 and the injury rate being 132, as compared with 1.00 and 131, respectively, in 1925. The fatality rate was, with one exception (1921), lower than ever before; the injury rate was lower, except for 1925, than it has been since 1919.

Smelting plants reported 24,399 employees, who worked 8,714,596 shifts, an average of 357 workdays per man. Accidents caused 20 deaths and 3,181 injuries, indicating a death rate of 0.69 and an injury rate of 110, as against 0.64 and 114, respectively, in the preceding year. With four exceptions, the fatality rate was lower in 1926 than it has ever been before; the injury rate was the lowest ever recorded.

On the whole, the metallurgical industry established a most creditable safety record in 1926, the Bureau points out.

How Much of the Vein Is Ore?

Notes on the Economic Balance That Controls the Width of Stoping

By E. G. LAWFORD
Rio Tinto, Spain

IN THE FOLLOWING NOTES, the word "ore" has been taken to mean rock containing sufficient recoverable mineral to insure mining and treatment at a profit. If this definition is accepted, it may be asked, "What is ore if total expenses amount to $5 a ton?"

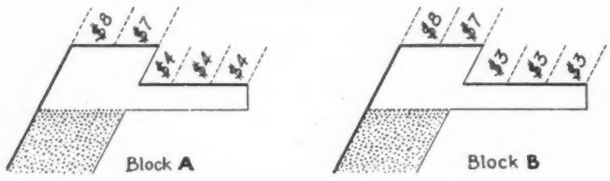


Fig. 1—Hypothetical cross-sections showing assays of ore

The answer immediately suggesting itself is, "Any rock that carries recoverable minerals valued at more than $5 a ton," but one must not assume that material carrying less than $5 a ton is waste and available only for stope filling.

In the instance of the hypothetical company, as shown above, the total over-all operating cost is $5 a ton, but to examine the economics of the situation it is necessary to express this differently. Assuming an output of 1,000 tons a day, the total expenditure will be $5,000, a figure that should be divided into two components. Within certain limits one of these will remain constant, irrespective of the tonnage mined and treated; the other will vary directly with the tonnage. This does not mean that the fixed component is simply "overhead." Although largely made up of overhead, using the term in its generally accepted sense to cover supervision, head-office expenses, directors' fees, and so forth, the fixed component also embraces the fixed factors of every operation of mining and treatment. For example, in hoisting by electric power purchased from an outside source, the fixed component will be the hoistman's wages, because these will be the same whether he hoists fifty skips or a hundred, whereas the power will be the component varying as the number of skips pulled. Every operator can multiply examples throughout the whole series of operations, and it is not within the scope of these notes to do more than indicate the importance of these fixed and variable components of the total cost. R. Gilman Brown dealt with this subject in greater detail in *Engineering and Mining Journal* of March 23, 1905. In regard to the hypothetical mine being taken as an example, let it be assumed that the fixed component is $1,500 a day and the variable component $3.50 a ton. We will consider a block which produces about 100 tons; $150 can be fairly allotted as its share of the fixed component. Fig. 1 shows an average assay cross-section through two blocks of ore; for the sake of simplicity, the sample widths have been taken as equal, 5 ft. each, normal to the dip. From each block a crosscut has been driven into the footwall. In Block A it has disclosed 15 ft. of rock carrying $4 recoverable mineral a ton; and, in Block B, 15 ft. of rock carrying $3 of recoverable mineral a ton. If it be assumed that by increasing the width of the stope 5 ft. an additional 33 tons could be mined and treated daily, the financial results of such a policy in the case of Block A and Block B can be examined. This has been done in the subjoined calculations, set out at length and requiring no explanation. An examination of the figures shows that by mining additional tonnages of the $4 ore, the daily profit is increased, and that in the treatment of the $3 ore the opposite is the condition. Yet both the $4 ore and the $3 ore are below what may be termed the standard grade of the mine—$5 per ton. The results of the above calculations are shown graphically in Fig. 2. It appears that some critical value exists between the $3 rock, which is waste, and the $4 rock, which is ore. A simple algebraical expression can be evolved to set forth the true position of affairs.

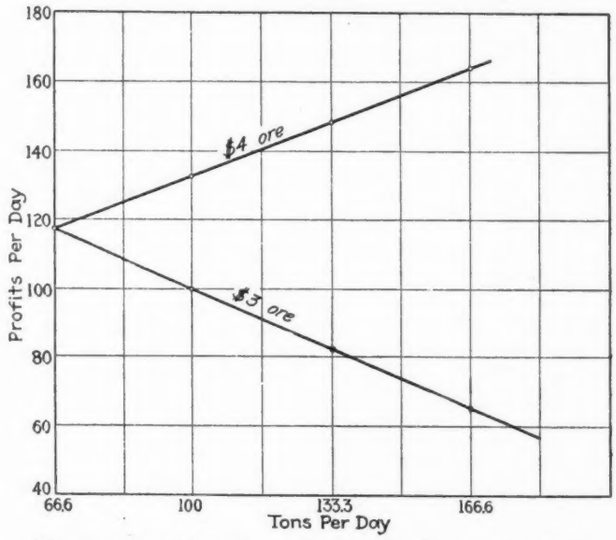


Fig. 2—Graphic representation of effects on cost of mining ore of less than average grade

Let n = output in tons per day
a = variable component of cost
b = fixed component of cost
v = recoverable value per ton.

Then $nv - (na + b)$ = profit; $n(v - a) - b$ = profit.

From this expression, it is evident that, where v is less than a, the expression $v—a$ is a minus quantity and, as n increases, profit decreases or loss increases. Where

however, v is greater than a, $v-a$ is a positive quantity and all increases in n, the output, make for increase in profit or decrease in loss. It may therefore be said that in every mine a Class 2 ore exists which, if used to increase tonnage, will yield a profit. It must here be clearly stated that calculations such as the above can be used as rough guides only. They cannot be pushed beyond a certain point, because the variable and fixed components of the cost of any operation are ascertainable only within certain limits. In this connection it must also be pointed out that the figures used are exaggerated, in order better to display trends; for example, it is not to be supposed that the blocks in question could have their production increased from 66.6 tons to 166 tons a day without affecting the fixed component, but the figures serve to emphasize the tendency, the truth of which is proved by the equation Profit $= n\ (v - a) - b$.

Results of Mining Various Tonnages of $3 and $4 Ore

Case	(2) Stoping Width, Feet	(3) Average Recoverable Value, Dollars per Ton	(4) Output per Day, Tons	(5) Recoverable Content, Dollars	(6) Costs, Variable Component	(7) Costs, Fixed Component	(8) Total	(9) Profit per Day, Dollars
Block "A" Addition of $4 Ore								
Case 1	10.0	7.50	66.6	500	233	150	383	117
Case 2	15.0	6.33	100.0	633	350	150	500	133
Case 3	20.0	5.75	133.3	764	466	150	616	148
Case 4	25.0	5.40	166.6	896	581	150	731	165
Block "B" Addition of $3 Ore								
Case 1	10.0	7.50	66.6	500	233	150	383	117
Case 2	15.0	6.00	100.0	600	350	150	500	100
Case 3	20	5.25	133.3	698	466	150	616	82
Case 4	25	4.80	166.6	797	581	150	731	66

Column 6 = Column 4 × $3.50. Column 9 = Column 5 minus Column 8. Column 5 = Column 3 × Column 4.

The example of hoisting may be again cited: if a certain tonnage is exceeded, a certain part will have to be dealt with on another hoisting shift; it will be necessary to employ a part of the second shift to hoist the remainder of ore left over from the previous shift, and so the fixed component has been changed; also, the fixing of the variable and fixed component is an exceedingly difficult matter and at best is only an approximation. Nevertheless, a knowledge of these two important factors will assist a foreman in a critical examination of the working of individual stopes in patchy orebodies.

Development ore falls outside both the classifications already given. Inasmuch as the development has to be done so that mining may proceed, some sort of disposal must be made of material from development faces. The logical light in which to regard such material is that it is ore broken, loaded, and trammed free of charge. That is to say, that expenses to be born by this ore only begin at the skip pocket. These expenses include the variable components of hoisting, delivery to mill bins, and the treatment charge. If the development material contains sufficient recoverable mineral to cover these items, it obviously contains potential profit and should be considered as ore. If the grade is low, and development ore is handled as waste, an irretrievable loss has been caused. If, therefore, the grade for the month is down and is to be brought up at all costs, it is economically more sound to stop development, temporarily, than to consider as waste the material broken, if it is really development (Class 3) ore.

The desirable grade (the figure set by the management to be reached) will be such that a substantial profit can be made monthly. This, in the hypothetical mine used to illustrate this article, might be $8 per ton. In many precious-metal mines working on patchy orebodies it often happens that an abnormally high proportion of the stopes run into low-grade patches simultaneously. Assume that grade falls to $7. No waste has been mined, but an unusually high proportion of Class 2 ore has been present in the stope backs. It often happens that during such a period in a last-minute effort to increase the grade of millheads Class 2 ore is used for fill and lost irretrievably: the grade is, of course, raised, but an irrecoverable loss of payable ore has occurred. Obviously, the better practice would be to suspend operations involving the breaking of Class 2 ore where this cannot be sorted and stored and must perforce be thrown into the fill to make room for stoping operations on the high-grade stringer and to place additional shifts and machines in the high-grade stopes where the ore is Class 1 from wall to wall. Such a course depletes the mine reserve of high-grade ore, and one may suppose that in many operations, if the underground force is satisfied that *no waste* is being sent as ore, it is better to let bygones be bygones and continue to break the Class 1 and Class 2 ore, because, just as sometimes all the stope backs are simultaneously in poor ore, so occasionally a higher proportion of working faces than is usual strike "better-than-the-average" ore. During these rare but joyful months, when, at the end of the first three weeks, the grade is several points above that fixed by the management, a record-breaking tonnage may well be sought by the operating force by breaking every ton of Class 2 ore that is available. This does not mean "stoping her high, wide, and handsome" and throwing hanging-wall or footwall waste with the ore. A record for tonnage and low cost per ton attained in this way is nothing but a loss of money to the company, as is clearly shown in the accompanying calculations and curves.

A Use for Indium Wanted

INDIUM is now being produced in Germany in both the metallic and oxide form, and though it is one of the rarest of the elements, and correspondingly expensive, some scientific uses may be expected even if it cannot be employed in industrial work. Indium is a ductile and malleable white metal, softer than lead, with an atomic weight of 115 and a specific gravity of 7.4. It shows two characteristic spectra: one at 4102 of an indigo-blue color, and a second weaker one in the ultraviolet part at 4512. Indium is tri-valent, its oxide being In_2O_3, the same as for iron and aluminum, in which group it belongs. However, indium differs from these two metals in that it can be precipitated in a solution of acetic acid by hydrogen sulphide. The metal is stable at ordinary temperatures, but ignites on heating. It is much like gallium in many of its properties. The element is found mainly in the flue dust from zinc smelters, and in metallic zinc.

Engineering and Mining Journal will be pleased to put those who wish to secure a small supply of indium or its oxide in touch with the sellers.

DISCUSSION

Repairs and Renewals

THE EDITOR:

Sir—In the issue of May 28, 1927, an editorial entitled "Spare Parts for Rock Drills" appeared. This editorial no doubt was correct, but there is another side to the question of spare parts for machinery in general that is very important to large operators.

Selling mining machinery is highly competitive and, to get the business, profits are cut to the limit. As soon, however, as the machine is sold, the manufacturer has a practical monopoly of the spare parts and repair business, and charges a monopoly price.

It is said that in some lines machines are sold at an actual loss, the manufacturer planning to make his profit on the sale of repair parts. This is perfectly legitimate, and no doubt it is good business for the manufacturer, for most of his customers have no choice but to come to him for repairs. But it makes it possible for a large mine with large well-equipped shops and competent engineers and workmen to make its own spare parts much cheaper than it can buy them, and often with decided advantages in delivery.

A typical example impressed me so much that it sticks in my mind. At a large open-cut mining operation in Canada, there are two 48 x 60-in. jaw crushers. The main journal bearings of these crushers are cast iron lined with babbitt and are removable. A spare bearing was supplied with the crushers. While I was plant engineer with the company it was decided to have two bearings on hand so that both journal bearings could be replaced at one time, because putting in a new one with a partly worn one threw the eccentric shaft out of level.

The manufacturer's estimate on the bearing was $212. As this seemed high, a drawing was made and the bearing completed in our own shops. All the work was done under job numbers. The pattern cost about $50; and the total job, exclusive of power overhead and engineering, was $98. The drawing did not cost over $5. If both bearings had been made at the same time, the machine work for the two would have cost less than it did for the one, as it would have been easier to center a pair of them in the lathe than to center one. Inasmuch as the manufacturing company already had drawing and pattern, and could no doubt do the work as cheaply as we could, it was asking a gross profit of $160 on a $50 job. These figures are quoted from memory, but they are substantially correct.

A mine shop should be equipped with machinery and have enough men to take care of any probable emergency promptly and efficiently. Fortunately, emergencies do not happen every day, and in the ordinary mine shop equipment is not used continuously. Men must be kept busy, and expensive machines kept in use as much as possible, as the overhead on them continues whether they are in use or not. It is obvious that it may pay to do work in a mine shop, even though, if all proper charges were made against it, it cost more than buying the finished job from a manufacturer. Just what work to do to "fill in" is a problem in management which will probably be met differently by each individual mine.

The above discussion, though suggested by your editorial, does not apply so much to rock drills as it does to some other lines. Manufacture of rock drills, as you say, requires precise measurements and specialized heat treatment, not likely to be found in any mine shop. But when a manufacturer asks several times the cost of production for a spare part, he is tempting the user to buy his parts from a "bootlegger." It seems to me that the manufacturer's recourse against the independent maker of parts should be either by suit for infringement, if there are patented designs involved, or by making prices reasonable if legal action is not possible.

Kirkland Lake, Ontario, Canada. JOHN DIXON.

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A "Business Policy" With the Prospector

THE EDITOR:

Sir—In the battle of engineer versus prospector, which still rages, present conditions seem to justify resurrecting the question of "down" payments. The arguments on both sides are old and need not be repeated, except the question, Would not small initial payments, made with discretion, do much to remove the causes of the present stagnation?

The prospector is unwilling to develop his prospect to the stage required by the engineer, because he feels that the best he can hope for is nothing but some more hope, even after his mine is accepted for development. The independent engineer, a strong factor in promoting new business, with his wide acquaintance and contacts on both sides, has little hope of consummating anything because of the gap. The buyer's engineer, with plenty to choose from, yet complains that, of the thousands examined, many have no possibilities and the rest are so undeveloped that he must spend much money to determine their worth or to make them producing mines.

The formula is "We will spend thousands to determine the value under option, but we will not spend a cent to develop your mine for you." The logic of this is hard to understand; it sounds less like business reasoning than a personal and human trait—the fear that somebody might get the best of you. Though good business demands that the other fellow shall not get the best of a bargain, this is not a "hoss trade," but an attempt to maintain an alarmingly dwindling industry. It hardly seems good business, if the buyer finds that the mine justifies his spending thousands on it, to refuse the possibilities of large profit just for fear the seller might make an insignificant and unearned bonus. The sum total of losses of this kind would be a small proportion of the money freely spent on exploration and on develop-

ment; the argument is not that losses can be sustained because they are small, but that small losses should be sustained if the policy creates more opportunity and more successes.

An established policy, administered with discretion, of course, which makes a small payment on a prospect when it is accepted for development, would stimulate prospecting and first-stage development, removing the causes of complaint on both sides. The prospector, relatively, takes tremendous risks. When he knows that he has an opportunity to make his business return even a portion of his meager requirements for carrying on, he will attack those objections made by the engineer, and offer his mines in a better developed condition. The independent engineer and the other men who so often stand between the seller and buyer, if they can but partially reimburse themselves for expense, will have much more incentive to downright work and productive effort. A surprisingly low "down" payment will in most cases secure much better terms of purchase, remove much hostility, and stimulate development where it is most needed.

Denver, Colo. C. R. WILFLEY.

* * * *

Technique of Geophysical Prospecting

THE EDITOR:

Sir—I wish to compliment Dr. Mason for his excellent and extremely interesting paper on physical exploration for ore. This extensive and complicated subject is indeed very difficult to cover in a manner intelligent to the layman, but Dr. Mason certainly has made the various problems and operations clearer than has been done in any previous paper.

Dr. Mason rightly considers the electrical methods the most important for prospecting for metallic ore deposits. For the last eleven years I have been occupied exclusively in work with electrical prospecting in different parts of the world and as, for the last five years, I have had the opportunity to work with both equipotential and inductive methods, alternatively, under the most varying conditions, perhaps I may be permitted to contribute a few remarks.

The inductive method is considered by Dr. Mason to have several basic advantages over other electrical methods. Theoretically several advantages may be advanced in favor of the electromagnetic and especially the inductive method, but there are certain practical features in favor of the potential method to be found in the practical execution and interpretation of a survey upon which Dr. Mason did not touch in discussing it.

Dr. Mason brings out as a disadvantage to the potential methods that the current distribution is determined by the ratio of the conductivities of the ore and adjacent ground, while in the case of the inductive method it is the absolute value of the conductivity which governs. Let us, for instance, investigate the conditions in a region which is favorable for electrical prospecting, a region with fresh crystalline rocks, where the depth of the oxidation is insignificant and where the rocks are covered with a mantle of glacial till. Such conditions are generally considered ideal for any method of electrical prospecting, and are found in the pre-Cambrian areas of Canada. The difference in conductivity between different rocks is here equalized to a great extent by the moisture content and, owing to the abundance of water, different soils do not, as a rule, show any appreciable difference in conductivity. Variations in conductivity are in the order of: 50,000 to 5,000 (expressed in resistance per cubic centimeter). The variations chiefly depend on the conductivity of the water and generally change gradually and slowly from one region to another and it is only seldom that water or the rocks themselves cause disturbances. In any case, such disturbances obtained in a potential survey would never be mistaken for indications of ore. The ground therefore may be considered as of rather uniform conductivity, where only moderate and gradual changes may be expected.

An orebody is very seldom uniform and formed of solid metallic mineral throughout. It generally occurs as a dissemination of metallic minerals with more or less richer parts. Sometimes the commercial ore occurs as enriched parts in a larger dissemination without definite boundaries, sometimes as isolated and more or less solid lenses or kidneys in a disseminated matrix. Richer bodies often occur along fault or shear zones which as a whole are slightly mineralized. An orebody nearly always varies in grade in different parts.

As a rule, the conductivity of an orebody, taken as a whole, is found to be less than the richer parts of the body and very much less than a specimen of the richest ore. Furthermore, the ratio of conductivity between adjacent parts is not found to be very high, generally varying between 5 to 50 and is rarely as high as 100 and only very seldom 1,000.

These figures can easily be checked by directly measuring the conductivity in an orebody, which is best done by studying the refraction of the current in passing from country rock into and through an orebody. It seems as if barren country rock near an orebody has higher conductivity than farther away; this is probably due to chemical reactions near the contact. In practice, therefore, very high ratios of adjacent conductivities seldom occur and thus the "saturation effect," mentioned by Dr. Mason, is scarcely ever approached.

However, the fact that the current distribution is determined by the ratio of the conductivity of adjacent areas sometimes proves to be an advantage, as it is possible to locate richer parts or smaller high-grade lenses in large or widespread disseminated areas. In Newfoundland, for instance, it was possible to determine parts richer in lead inside the large orebodies.

There is one more advantage of the potential methods that I would like to point out and that is the independence of the scale. It is possible at the same time with the same set-up to delimit a very small orebody, as well as a large one. Therefore in complicated geological structures, the problem of finding and outlining small irregular bodies is comparatively simple. This can be done without making any changes in set-up or of the frequency, while the contrary is the case with the inductive method. One must keep in mind that the inductive method is not independent of the scale as Dr. Mason, in speaking of laboratory model tests, pointed out. It is true that the strength of the current induced depends directly on the absolute conductivity, but it also depends on the size of the conducting body, i.e., its geometrical dimensions, because the induced current at any point depends on the total area of the conducting mass which is under the influence of the primary magnetic field. Thus, in using the induction method, if conditions such as frequency, etc., are adopted which will give response from considerable depths and exclude manifestation of structural differences such as faults, water courses, etc., small orebodies will not be detected. Where, on the other hand, we make the conditions suitable for the detection of the small orebody, we shall get strong indications from faults, water courses or

contacts, thus covering the ground surveyed with a multitude of indications.

In using the potential method, especially when tracing equipotential lines, the observer is steadily in close touch with the features he is passing over. Changes in conductivity cause phase differences, and even a slight change in conductivity is immediately noticed in its effect on the sound in the telephone used, and the ease with which the equipotential points are found. Thus the sound in the telephone tells an experienced operator a whole lot of the character of the ground he passes over. If desirable, the phase differences are determined accurately, thus giving a measure of the conductivity.

We must not let the question of great depth worry us too much, as in the majority of cases it is not of moment. In the district mentioned 100 ft. is an unusual depth from the surface to the orebody and it is extremely seldom that an orebody is located below 200 ft. of cover, at least so far as known. A depth of from a few feet up to 40 or 50 ft. is the most common.

Though we have the choice of using any electrical or electromagnetic method in the prospecting work conducted by the company with which I am associated, if the conditions make it feasible, we prefer to first use the potential method. For details, naturally, the best is to use one method for checking the other.

In younger sedimentary formations or in districts where the oxidation has reached a considerable depth, conditions for electrical prospecting for metallic ore are much more difficult and I would say that, with the present state of development of the methods, it is still only in rare instances that electrical prospecting can be successfully applied. HANS LUNDBERG.

Toronto, Ont.

THE EDITOR:

Sir—I think it is generally recognized that no single mode of physical exploration for ores possesses advantages of so predominating a nature that any general brief may be drawn for its superiority. Theory and our numerous field tests in regions selected for diversity of geological conditions all emphasize the important rôle played by the geology of the district in determining the most suitable procedure. Holding this opinion, I am naturally especially sorry if my recent paper on physical exploration conveys the impression of a too general emphasis upon the advantages of any particular method.

In reality we consider the potential method and its possibilities very important, and it has occupied our attention to an extent perhaps only surpassed by the inductive method. Not only has this been true in a theoretical and an experimental sense, but much effort has been devoted to improving the rapidity of field technique with the potential method. The potential method has been applied, along with the inductive, in many of the surveys which we have conducted with successful results in the delineation of ores.

With regard to certain limitations of the potential method, the major divergence in opinion between Mr. Lundberg and myself seems to arise in the technical interpretation of the phrase "an appreciable difference in conductivity." We agree as to the facts about the conductivities of the ores and of cover, as stated in Mr. Lundberg's letter.

A difference in resistivity of 5,000 to 50,000 ohms as mentioned by Mr. Lundberg is a ratio of ten to one. Now the fact is that, in the potential method, a ratio of conductivities of ten to one is usually nearly as effective as a ratio of ten thousand to one. Nevertheless, as Mr. Lundberg points out, in many districts and especially under favorable circumstances where orebodies lie under only fifty feet of glacial till, it is easy to distinguish between topographic effects and those due to ore. Under more difficult conditions where the orebodies lie deeper and show greatly diminished response, the problem of the topographic effect becomes ultimately of supreme importance. The advantages of the inductive method as developed by us have been found very real under such circumstances.

Concerning the comments made under the topic "independence of scale," we have successfully avoided all the difficulties attributed to the inductive method by Mr. Lundberg, in our applications to ores.

I believe that the scope of physical methods of prospecting is now clearly in process of extension, that difficulties are gradually being overcome and the technique improved. A number of years ago electrical prospecting was tested, but without commercial success warranting continuation, over the limestone sediments of the southwest Wisconsin lead and zinc district. In the last few weeks an orebody discovered here by us has been tested by drilling and we are hopeful that further successes for physical prospecting will follow in this district. We believe that other types of deposits not at present considered favorable for electrical prospecting will in the future become accepted fields for the utilization of the physical methods.

I am glad that my unintentional overemphasis of the inductive method has been called to my attention, and appreciate very much Mr. Lundberg's courtesy in the matter. The potential method appears to us to have a most valuable rôle, especially in the exploration of structure, and I hope that I shall have an opportunity to enlarge upon this subject in the near future.

University of Chicago, Chicago. MAX MASON.

[We are glad to give publicity to the comments of Mr. Lundberg and to the reply of Dr. Mason. The subject of geophysical prospecting is so new, so broad, and so complicated, however, that, unless a clear-cut point of issue can be raised, the result of a discussion within the limits of space imposed may prove confusing to the average reader.—EDITOR.]

* * * *

Geophysics, Physics, and Psychics

THE EDITOR:

Sir—I have been interested in various articles appearing from time to time in *Engineering and Mining Journal* on locating water or mineral deposits by means of a forked stick or similar device, usually known as "dowsing." Since my own views on this subject are entirely different from those I have read, perhaps they may be of interest to others.

Some years ago I visited a mining camp in southern Colorado, and spent an evening with the superintendent of the largest mine in the district. In the course of the conversation he told me that a dowser had been to see him sometime previously, and that he was curious enough to pay $25 for an exhibition. The dowser, he said, indicated to him the exact position of a vein of which he had no knowledge. He was then crosscutting to intersect the known veins, and was interested to see if there was anything to the dowser's information. He found the vein almost exactly as described, and asked me

if I could offer any explanation." I told him coincidence might be an explanation, if it explained anything.

About the same time I was superintending the construction of a mill in Colorado. One of my associates in this work had read about locating mineral veins with a forked stick, and he suggested that we try it. I agreed, but with the stipulation that he was to carry the forked stick. As we tramped over the hills he remarked several times that he felt a perceptible tug on the stick, and I concluded that his imagination was working overtime. Suddenly he stopped, and apparently was making a great effort to hold the stick horizontally against a force which was attempting to pull it down. He called my attention to it, and as I looked him over in an incredulous way, he said, "Well if you do not believe it, try it yourself." I did, but to me it was simply a forked willow stick we had cut a short time before. I handed it back to him, and immediately apparently the tugging started again. I concluded at the time that if there was not a mineral deposit where we stood, there was at least an interesting psychological problem connected with the affair.

The phenomena of dowsing does not appear as obscure to me now as it did then. The mistake is usually made by confusing a psychical phenomenon with a physical phenomenon. Dowsing, as I see it, is purely a psychical phenomenon. It finds almost an exact duplication in the very common psychic phenomena known as table tipping and automatic writing. It is, in fact, essentially the same thing. While dowsing cannot very well be investigated experimentally, every one can easily experimentally investigate table tipping and automatic writing. Few people who have scientifically investigated these common phenomena doubt their reality. Everyone who has scientifically investigated them knows about their unreliability. Sometimes results are obtained bordering on the miraculous; then again, at other times, the results are entirely negative, apparently without cause.

In dowsing, as in table tipping and automatic writing, the operator, or automatist, is the essential factor. Although the phenomenon is common, and although anyone can observe it so as to eliminate fraud or coincidence, not everyone can produce it. This is probably analogous to the fact that copper conducts electricity exceptionally well, whereas rubber does not; and between the two there are all grades of possibilities.

There is not the slightest reason to believe that any relation exists between a forked stick and the water or mineral deposit that it is supposed to locate. The force acting on the stick in dowsing; the force moving the table in table tipping; and the force guiding the pencil in automatic writing is evidently, partly or entirely, derived unconsciously from the operator. But two important factors enter into the investigation: One is the source of the force (physical), and the other is the intelligence that always accompanies the phenomena (psychical).

In dowsing, what is the intelligence that brings the physical force into action to dip the stick? In table tipping, what is the intelligence which moves the table according to suggestion or rationally answers questions? In automatic writing, what is the intelligence that guides the pencil to draw pictures, imitate a signature, and frequently gives replies, which, to say the least, are startling? Does the intelligence come from the automatist, or does it come from a source outside of the operator? Is the intelligence incarnate, or is it discarnate? If the intelligence comes from the automatist, or operator, it certainly does so unconsciously. I have experimented with many different people, and not one would say that either the force or the intelligence came consciously from them, and the curious thing is that the intelligence itself disclaims any connection with the automatist, except, of course, to use his organism.

The person who can unravel this mystery will shine above Copernicus, above Newton, and above Darwin. On it, as I see the matter, will depend the solution of the age-long quest as to whether mind is inseparably associated with matter, or whether it can exist independently of matter. This, of course, is the essential problem of religion. It does not seem to be incapable of solution, and the riddle will some day be solved. Some years ago scientists contended that because it was impossible to get particles of the materials composing the stars, the stellar universe must forever remain a mystery. The discovery, or the invention, of the spectroscope changed all that. It may be that some day a similarly easy solution will be found to the psychic problems now so keenly interesting mankind.

Nobody realizes better than I do that these phenomena are ridiculed and explained on the basis of fraud, but ridicule and fraud do not explain anything except the mental attitude of the one who asserts them. Anyone can observe these phenomena, and anyone who claims to know even the elements of research and experimentation can eliminate fraud and coincidence without much trouble. I eliminated them by experimenting with friends and members of my own family and household. I even eliminated them from consideration of fraud and coincidence by giving mental directions and by mentally (not audibly) asking questions. In table tipping, for example, the table would respond to my mental directions when there was no physical contact between me and the table. These phenomena are very common, and I am simply mentioning them here to show their identity with the much discussed subject of locating water or mineral deposits with a forked stick. Those who can produce the phenomena of table tipping can usually without much difficulty produce the phenomena of automatic writing, and I should confidently expect, on experimentation, to find that they could also produce the phenomena of dowsing, and vice versa. These phenomena are admittedly unreliable and unsatisfactory, but as one roams over the mining regions of the West and sees the innumerable abandoned prospect holes dug by hard-headed prospectors and intelligent engineers, he is far from impressed with the infallibility of their judgment, even on matters they claim to know about.

There is clearly no relation between electrical prospecting, or geophysics, and dowsing. One is based on physical phenomena, on the properties of matter; the other is a psychic phenomenon, and has no relation to properties of matter; the phenomenon is primarily dependent on the operator, but the operator does not direct it nor does he consciously affect it. He is in no way directly responsible for the results.

I, myself, would certainly not think of prospecting for mineral on the basis of dowsing, nor would I accept any statement obtained through automatic writing without subjecting it to the closest scrutiny, the same as I would give to any other statement from any source. Nevertheless, I would get more real satisfaction in the discovery of the true explanation of these pyschic phenomena than I could possibly get from all the wealth produced by all the mines in the world.

Denver. WILLIAM E. GREENAWALT.

INDUSTRIAL PROGRESS

Cementation and the Water Problem in Mining

ORDINARY grouting with cement slurry has been and still is a useful method of sealing water in shaft sinking and tunneling where the pressure of the influx is small and the fissures or spaces to be filled are large enough to offer little resistance to the flow of grout.

The first record of the use of grouting in shaft sinking occurred in 1864 at the sinking of the Rhein Preussen pits, in Germany. Much valuable work was carried out in subsequent years by M. Portier in the coal fields of Belgium and northern France. The methods employed suffered from many disadvantages, and it was not until 1906, when M. Albert François proved that it was possible to inject grout from the inside of a shaft below permanent water level, that mining engineers accepted grouting as an established method of shaft sinking in wet ground.

In 1911 M. François introduced his partly developed process into England, where after much patient research, the surmounting of difficulties led to the success that the method has achieved, and at present the François Cementation Company, which operates the François patents, is by far the largest firm of British sinking contractors. In addition to working in Britain the company has operated extensively in South Africa, on the continent of Europe, and in India. To give only a few instances of those who have availed themselves of the process may be mentioned, apart from the numerous British collieries, such mines as Geduld, Brakpan, East Rand, Modderfontein, Comet Deep, Daggafontein (South Africa), Rio Tinto (Spain), and Nundydroog (India).

The term "cementation" is used to mark the striking advance made over ordinary grouting by either gravity or direct air pressure. It signifies the injection of liquid cement mixture under high pressure into strata so that the finest fissures are filled in such a way as to render them impermeable to water or gases. Specimens of various types of treated rock are illustrated in Fig. 1. They show how completely the finest fissures and hair cracks have been filled.

The special features of the patented François cementation process as opposed to ordinary grouting methods are principally the following:

1. The liquid cement mixture is drawn from mixing tanks into a pump whence it is forced through pipes, flexibles, and boreholes to the desired spot.

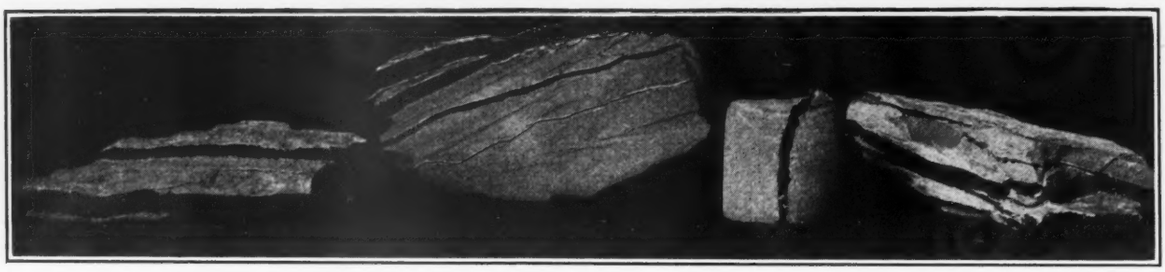
2. Compressed air is not used. The cement mixture is moved directly and continuously by the pump pistons.

3. The cement column is kept under constant and effective control. The pump can easily and quickly develop pressures up to 3,000 lb. per square inch, and can also work at no pressure whatever. Control is simple and flexible, it is claimed.

4. The cement tanks and pumps may be hundreds of feet away from the point of application while hydraulic-pressure gages keep the pressure under strict observation.

5. The injection stand pipes are sealed into the rock by special methods, and through these holes are drilled up to

Fig. 1—Specimens of rock treated by cementation



200 ft. in depth or length, each feeder being injected as it is encountered.

6. Chemicals lubricating in their action are employed to insure the cementation of hair cracks and fine fissures and to assist in sealing the pores of porous rocks.

7. Experience which can be gained only from a long and varied practice and which determines the kind of cement, thickness of mixture, quantities, chemicals pressures, depth of boreholes,

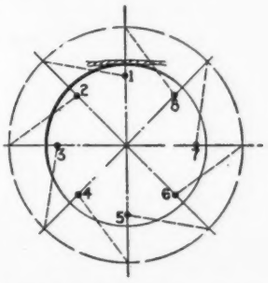


Fig. 2—Plan view of arrangement of holes for cementation of a circular shaft. The two planes represented by the concentric circles are 100 ft. apart vertically

length of injection, and related factors essential to success.

Those controlling the process claim that it surpasses other grouting methods in scope and extent of application, as well as in efficiency.

The Dravo Contracting Company, of Pittsburgh, has effected an arrangement with the François Cementation Company whereby it may make application of cementation and use for François patents on this continent. Major J. S. Crawhall, who has had charge of some of the biggest cementation shaft-sinking jobs in Great Britain, has joined the Dravo company.

Cementation is not necessarily confined to mining work, and rapid strides have been made in its application to civil engineering problems. It is outside the scope of this article to enumerate the numerous and diversified mining problems that have been dealt with, but these include the following:

1. Sinking of shafts through water-bearing strata without the use of pumps in a much safer manner and for all time preserving a dry shaft.

2. Sealing of feeders in existing shafts to avoid the cost of continuous pumping.

3. Treatment of tunnels and mining drifts in heavily watered strata to insure dry excavation or in subsequent sealing of exposed fissures.

4. Construction of underground mine dams in such a way as to guarantee water-tightness.

5. Consolidating and rendering impervious to the passage of water the foundation of surface dams and thus avoiding the costly excavations entailed by core-wall trenches.

6. Consolidating gravels and loose ground to permit excavations or to serve as foundations for vibrating machinery and excessively loaded buildings.

A few typical examples given in the following will be of interest:

Shaft Sinking and Tunneling

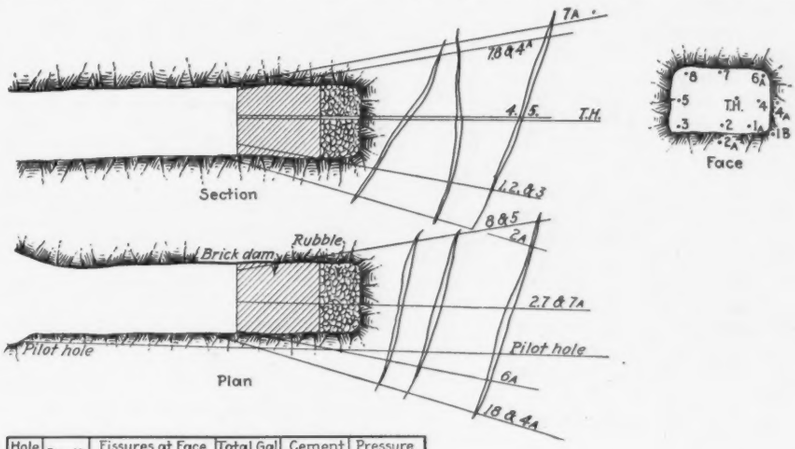
The ground is cemented from the shaft bottom and taken out in lengths of from 60 to 100 ft. This is carried out through boreholes eight to forty in number and 2 in. in diameter, depending on the nature of the fissures and to what extent chemicals are necessary to aid the sealing of fine hair cracks. The drilling is usually done by percussive hammer drills and the holes are treated 15 or 20 ft. in advance of the length for excavation, so as to leave a plug of cemented ground to facilitate the next length of treatment.

As an example of the more simple type of cementation work may be mentioned that done at No. 3 shaft at Llanbradach, in South Wales in 1925. Shafts Nos. 1 and 2, sunk many years before in the same pit yard, are well known for having each pumped 2,000 gal. per minute, which flow was eventually shut off by cast-iron tubbing.

No. 3 shaft was sunk by the François process over a vertical distance of 540 ft. through hard sandstone. No pumps whatever were needed. The progress was 60 ft. of completed shaft per month, including brick lining, and the total residual feeders amounted to not more than two gallons per minute. Fig. 2 shows the disposition of boreholes in such an example as Llanbradach.

Shafts are sometimes carried unexpectedly into heavily watered ground or into larger quantities of water than were looked for at the outset, and the shaft bottom is consequently lost. For recovering the pit bottom without pumping and for sealing off the water pending the adoption of special methods of sinking, a perfectly sound job can be made by installing a shaft plug while the shaft is full of water. This is done by placing pipes in the shaft, putting in a quantity of broken bricks or similar material, and injecting grout; but much experience is needed to know what is actually taking place at the shaft bottom and to control the operations accordingly. Such an example is afforded by Fig. 3, which shows 16,000 g.p.m. being pumped out of Blackhall colliery shafts, England, in 1912. Further feeders drowned the pumps and resort was made to cementation, which effectually dried the shafts.

Fig. 3—A flow of 16,000 gal. per minute being pumped out of Blackhall colliery shafts, England, in 1912



Hole No.	Depth	Fissures at Face Gal. Per Min.	Total Gal. Per Min.	Cement Injected Tons	Cement Injected Cwts	Pressure Injected to
1	20	30'	30	1	5	2,000 lbs
1B	47½	55' 10' 5' 30'	98	1	15	1,600
2	70	15' 20' 30' 4' 8'	109	1	12	3,000
2AT	60	8'	6		8	800
3	51	25' 5' 18'	45		13	2,700
4	M.H.				12	2,000
4A	63½	9' 9'	2		11	2,200
5	55	5'	5		2	1,800
6A	66	15' 18' 9'	100	4	18	2,000
7	55½	10' 30' 7'	97	2	2	1,700
7A	72½	9'	2		5	2,200
8	51	10' 15' 15'	70	1	12	2,000
Pilot	110	3' 7'	30			

Fig. 4—Plan and section showing the method of cementation of a drift in fissured ground

Fig.5—This concrete cylinder, in the Geduld mine, South Africa, was built and injected to seal a fissure cut in drifting, from which 500 gal. of water per minute was flowing

Feeders in the sides of shafts can be rendered dry by direct cementation without the assistance of any lining material, but this is usually more difficult than by treating the ground in advance of sinking, and lining, especially in the case of mine levels, is sometimes advisable.

At Tullegarth colliery, in Scotland, in 1925, a fissure 8 in. wide carrying 400 g.p.m. under pressure of 300 lb. per square inch was successfully sealed without any recourse to lining, and grout was finally injected at a pressure of 2,000 lb. per square inch.

Underground Drifts

The methods of dealing with feeders in drifts, crosscuts, tunnels, and other workings are in many ways similar to shaft sinking. If ground is known to be water-bearing a length of rock is treated, maybe for 120 ft., to allow 100 ft. of dry excavation. More often, however, water is met unexpectedly, and if the quantity is great, a dam may have to be installed before a proper injection of the grout can be made. Such an arrangement is shown in Fig. 4, which shows an actual case in South Africa. The feeders met in drilling are given in the table, together with the cement injected and the final pressures applied.

In another case a fissure giving 500 g.p.m. was cut by a drive in Geduld mine, South Africa. A concrete cylinder was built and injected with the result that the feeder was sealed as shown in Fig. 5.

In the construction of underground dams great difficulty is sometimes experienced, not in making the dam itself water-tight but in getting the surrounding rock dry. Flank holes injected with cement are often necessary to prevent leakage in this manner, and this combined with the special method of construction of the dam makes it possible to guarantee results.

Civil Engineering Work

The general principles involved in the foregoing descriptions illustrate the diversity of problems and show the possibilities of the application of cementation to many engineering difficulties. Grouting has often been employed by civil engineers, but the development of the François process, it is claimed, is a marked advance on most of the methods hitherto employed and the results are much more effective. Here it is only possible to indicate in general outline some of the standard instances of the application of cementation.

Much money has been saved in reservoir construction by the Birmingham (England) and other corporations, when, instead of digging deeply into rock for water-tight cut-off trenches, or in length by wing trenches reaching impervious strata, the rock has been treated by cementation through boreholes, which has prevented the passage of leakage water. In the same manner, leakages in existing reservoirs have been sealed by the process. Two interesting examples with total water loss of 1¼ and 1½ million gallons per day were reduced by 98.5 per cent and 99 per cent, respectively, and at the present time work is in progress to seal no less a leakage than 221 million gallons per day passing under and around a concrete dam, 300 ft. high, in Spain.

In foundation work many interesting cases can be cited, not the least, perhaps, being the cementation of the Cape Town grain elevator's foundation. The ground in this case consisted of dump material including ashes, clay, and rubble, the water percolating through this material as through a sieve with the rise and fall of the tide. Pumping was of no avail, and it was decided to form by the cementation process a solid and water-tight barrier which would act as a retaining wall around the area to be excavated. The material treated was 20 ft. deep, and a length of 828 ft. of barrier was constructed with entire success, it is said, so complete, in fact, that wormholes in wood mixed with the débris were filled with cement.

It is noteworthy that the restoration of St. Paul's Cathedral, in London, is being carried out by the François process. The rubble filling of the piers supporting the dome is subsiding, and this is being checked by complete filling of all interstices with cement—work which calls for skill, experience, and care.

How the Mine Trolley Frog Developed

By H. N. Richards
Westinghouse Electric & Manufacturing Co.

PROBABLY no other fitting used in the trolley system of a mine has caused as many troubles as the trolley frog. These troubles were due both to inherent faults in design and to improper location of the frog. As the lengths of haulageways were increased with greater production, and as the use of locomotives for gathering the ore superseded the use of mules, more thought was given to increasing locomotive speeds. It then became necessary to give the trolley system, and particularly the trolley frogs, more consideration.

An early type of trolley frog consisted of a body casting in which the trolley wire was clamped to the main body by means of a separate casting. The trolley wire was held in the end of the runner by means of a wedge which was forced down with nuts which in turn were threaded on lugs of the main casting. This type of frog presented difficulties both in installation and operation. The lugs on which the nuts threaded were split to allow the wire to pass into the groove, and trouble was experienced with the cross-threading of the nuts. The trolley wheel ran directly from the trolley wire to the runner of the frog. The trolley wire was more or less flexible, the weight of the frog causing a hard spot in the line. Thus the wheel tended to jump and to arc at the transition point. See Fig. 1.

A later development was a flexible

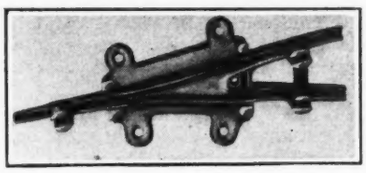


Fig. 1—Old style trolley frog

approach which was attached to the body of the frog with bolts. This was a great improvement over the old types, in that it afforded an easy transition of the trolley wheel from the trolley wire to the runner of the frog. However, it was difficult to force the trolley wire in the grooves and hold it there until the approaches were bolted in place. See Fig. 2. Finally a type of approach was worked out whereby the tension of the trolley wire held the approach in place. This was a decided improvement over the other types.

While all of these improvements were

being made in the approaches, the pan of the frog remained unchanged. The runners were terminated about 3 in. from the center of the pan, leaving a space of about 6 in. between the runner ends. As the flanges of the trolley wheel rode the pan across this space, this part of the frog was cut through, although the runners would not be worn, thus greatly shortening the life of the frog. Because the tangent part of the frog is used more than the turnout, a deep groove was worn between the tangent runners, making it difficult to make the trolley wheel take the turnout. See Fig. 3.

A new type of frog has been developed on which the runners are overlapped so that the wheel travels on the runners at all times and does not touch the pans. Fig. 4 shows the overlapping runner frog. Two desirable results in operation have been accomplished by this development—namely, increased life and positive tracking.

It is a common sight on outside

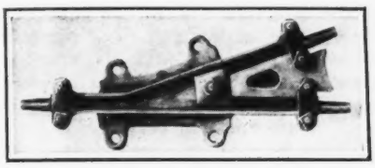


Fig. 2—Trolley frog with flexible approach

haulageways around mines to see frogs of the open pan type in which the pan is cut completely through. The same condition exists also on some inside haulageways. This condition increases the accident hazard because a trolley wheel is likely to jam in this groove and either break the trolley pole or tear down the overhead. From actual service tests it has been demonstrated that the overlapping runner frog has from three to four times the life of the open-pan type. When the overlapping frog does wear out, the runners wear through, thus eliminating the hazard of a possible catching of the trolley wheel.

The second advantage is positive tracking. With the elimination of the groove in the pan and the closing up of the gap between the runners, the tendency of the wheel to jump at the frog or to continue on the straight line while the locomotive takes the turnout is eliminated. Though this type of frog had been in use on railway properties for several years, it was

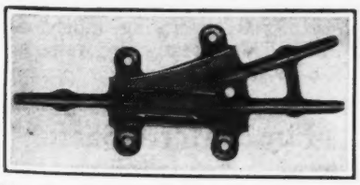


Fig. 3—Another old style trolley frog

thought questionable whether or not it would work out in mining service. Rigid harps are used in railway service and swivel harps are used on mine

Fig. 4—Overlapping runner type of trolley frog

trolleys. For this reason it was thought possible that the wheel would not follow the turnout runner. However, when service tests were made, the swivel harp was found to work even better than the rigid harp. It has been found that locomotives can travel faster with the overlapping runner type of frog.

Care should be used in setting frogs. They should always be lined true with the tangent track to secure the best operation. In mining service it is impossible to give a hard-and-fast rule for the location of a frog relative to the turnout point. This is governed by the overhang of the trolley pole, and as the location of the frog is determined by the height of the wire from the rail, it may differ at every frog point. The wireman should determine the point at which the frog will operate and install the frog without clinching the approach lips around the wire. He should then observe a number of passages of a wheel under the frog, and if the wheel does not take the turnout it should be moved closer to the track frog. If the wheel jumps while running from the turnout to the tangent track, the frog should be moved toward the switch points. After the proper location has been determined by this means, the approach lips may be clinched around the wire, making permanent installation.

Air Preheater Improved

Changes have recently been made in the design of the Combustion Engineering Corporation's plate-type air preheater. Clean-out doors are now provided in the heater casing which permit blowing the entire surface of the gas passages with steam or air lances. This can be done while the unit is in operation. Wherever possible, two such doors are provided in each heater so placed that the entire heating surface can be blown. Opposite these doors the spacer bars in the gas passages are cut away to form a lane through which a lance can be inserted. These doors can be readily opened and are small enough so that the heaters can be cleaned while the unit is in operation.

To eliminate leakage from the air side to the gas side of the preheater, the elements are welded to the casing by means of a sealing strip which also holds them in place and permits them to expand relatively to the casing. This construction also greatly reduces the amount of erection work.

Moreover, it has been found that what is known as the "S" flow design results in the most effective transfer of heat from gas to air. In this design, the air inlet and air outlet are located on opposite sides of the heater, and the baffles are so arranged that all lanes of air travel are of approximately uniform length, which assures an even distribution of air in all parts of the heater. The advantages of this construction, which derives its name from the fact that the air lanes are of "S" shape, warrant its use wherever possible.

Core Drill Has Advantage Over Deep Hole Drifter

A use for the new light diamond core drill recently introduced by the Sullivan Machinery Company is found in underground prospecting of the kind done in the last few years with drifter drills and special jointed steels to depths of 30, 50 or even more than 100 ft. This kind of prospecting was a development from underground diamond drilling in the first place, and diamond drill rods pinned or screwed together were used for the work at first. The new diamond drill has the advantage of lightness possessed by the drifting type of drill, and, in addition, takes a core, thus giving greater accuracy than the hammer drill prospecting outfit could possibly give.

The drill referred to, which is known as the "Baby Turbinair," was described in other respects in the issue of Dec. 17, 1927, on page 999.

BULLETINS

INSULATION—Valuable data on high-temperature insulation has been compiled by the Celite Products Company, of Los Angeles, in the form of a 16-page bulletin.

COMBUSTION — A pamphlet entitled "Aims and Tendencies in Steam Generation and Combustion Engineering" is being circulated by the Combustion Engineering Corporation, New York. Some of the recent developments in the combustion field are set forth by the author, Martin Frisch.

BRAKES—The Cutler-Hammer Manufacturing Company has issued a small pamphlet explaining the construction and operation of all types of magnet brakes, for alternating and direct current. Tables are given showing the exact size and type of brake for use with the various types of mill and crane motors.

COMBUSTION — "Metered Combustion Control" is the title of an eight-page pamphlet issued by Leeds & Northrup Company, Philadelphia. The selection of equipment for controlling automatically the combustion in pulverized-coal furnaces is discussed.

REFRACTORIES — Facts about refractories are given in a 30-page pamphlet by the Denver Fire Clay Company, Denver, Colo. This is Bulletin 140.

WELDING — Acetylene generators for use with welding and cutting apparatus are covered in Bulletin B-200C issued by the Alexander Milburn Company, Baltimore, Md.

CYANIDING — Allis-Chalmers Manufacturing Company, Milwaukee. Bulletin 1826. Cyanide plant equipment.

NEWS OF THE WEEK

Summary

STATISTICS of the Phelps Dodge Corporation for 1927 show that the number of mine accidents at the various branches of the corporation are reduced 50 per cent as compared with the preceding year.

* * *

Properties of the Silver Reef Consolidated Mines Company in Washington County, Utah, are purchased at a receivers' sale. Development of the properties is to begin immediately.

* * *

Schlumberger Electrical Prospecting Methods completes survey of 1,300-acre tract on Cape Breton Island for the Consolidated Mining & Smelting Company of Canada, Ltd.

* * *

Texas Gulf Sulphur Company plans erection of a large plant and extensive operations on 500 acres of land situated near Boling, Tex., and recently acquired by the company.

* * *

Mohawk mine, in the Michigan copper district, produces 22,000,000 lb. of refined copper in 1927, which is the largest annual output in the history of the property.

* * *

Old Frisco mill, situated near the Highland Boy mine of the Utah Delaware Mining Company, at Bingham, Utah, is destroyed by fire.

* * *

Another quicksilver camp, situated about 75 miles south of Marathon, is established in the Big Bend region of Texas.

* * *

Several district mine inspectors of Colorado expect an expansion in mining activities of the state during 1928.

* * *

Hecla Mining Company, of Wallace, Idaho, prepares to sink main shaft an additional 800 ft.

House Slices $30,000 From Bureau of Mines Appropriations

Reduction From Amount Recommended by Bureau of the Budget Made in Items Covering Increase for Economic Surveys and Oil-Shale Investigations

By Paul Wooton
Special Washington Correspondent

NO ADDITIONS or important changes were made by the House of Representatives in its consideration, on Jan. 10, of the appropriations for the Bureau of Mines. As approved by the House the bill carries a total of $2,532,000. This is a reduction of $30,000 from the amount recommended by the Bureau of the Budget. The reduction of $30,000 was made in the committee. Of that amount, $25,000 was lopped off the increase for economic investigations of the mineral industry. The other $5,000 was deducted from oil-shale investigations. An increase of $50,000 had been asked so as to take care of the direct requests from various departments of the government and from the industry for surveys and reviews of the mineral resources of the world, with particular reference to mineral and metallurgical activities in the United States and the needs of the military branches of the government. This appropriation was requested particularly by Secretary Hoover. It also was endorsed by the American Institute of Mining and Metallurgical Engineers.

Representative Englebright, of California, had planned to introduce an amendment restoring this item, and also to increase the amount available for the experiment stations, but it became evident at the last moment that there could be no assurance of enough votes to overrule the committee, so proposed amendments were withheld. They will be presented by Senator Oddie in the Senate, however.

In reporting the bill to the House, the committee also made public the testimony before the appropriations committee. In explaining the item which the committee cut, Director Turner, of the Bureau of Mines, made this statement to the committee:

"There has been a great deal of discussion among technical men all over the world regarding uncontrolled production and consumption of minerals and mineral products, and even a casual inquiry will show that in some cases within a short time we will be facing total exhaustion. That brings up the question, perhaps, not of restricted use, but the effective use, the avoidance of wasteful use, at least, of these minerals and mineral products. It is a proper subject of study and might well include a broader survey than that mentioned here. Some one will certainly have to undertake it at some time, because this situation is going to involve future international agreements. Certain nations are blessed, or favored, with deposits of mineral raw materials which are needed by others, and in some cases trade arrangements are being made between one nation and another whereby the door is closed to other users of the same material. This consideration has been expressed with the phrase 'necessity of the open door,' as between friendly nations as to their resources of raw mineral products.

"This is a study that has never been systematically undertaken by any branch of this government, and yet it is one we are hearing more about every day. These requests seem to crystallize some of the talk about the necessity of a comprehensive study by a federal agency."

The principal items in the bill, as approved by the House, follow: Mineral mining investigations, $125,000; oil gas and oil-shale investigations, $198,260; oil-shale investigations, $75,000; mining experiment stations, $173,000; helium plants, $462,000; helium production and investigation, $75,000; potash explorations, $100,000; economics of mineral industries, $250,000; testing fuel, $158,500; operating mine rescue cars, $342,630; investigating mine accidents, $399,470.

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Fire in Morris Shaft

Fire, which recently broke out on the 300-ft. level of the Morris shaft on the property of the Consolidated Coppermines Corporation, at Kimberly, Nev., was bulkheaded off in the shaft. At the last report, the shaft was being flooded to put the fire out, and the orebody had not caught fire.

Colorado Situation Appears Promising for 1928

District Inspectors Express Views Concerning Outlook in Mining Areas of the State.

THE following is a résumé of mining work in Colorado as made by the inspectors of the several mining districts:

According to T. R. Henahen, inspector of district No. 1, comprising Boulder, Clear Creek, Gilpin and Grand counties, the low prices which have prevailed since September, 1926, have retarded the proper incentive in his district. Tungsten mining, however, has been more profitable than at any time since 1918.

M. J. McCarthy, inspector of district No. 2, comprising Custer, El Paso, Fremont and Teller counties, was much pleased with the determination shown by mine owners and miners, and said that many new veins were opened up and numerous mills rehabilitated. Indications were that greater activity would take place during 1928, particularly in the Cripple Creek section.

R. J. Murray, inspector of district No. 3, comprising Lake, Eagle, Chaffee, Summit, Pitkin, Park, Saguache, Mineral, Rio Grande, Garfield and Gunnison counties, pointed out that there was extensive development work in his district during 1927, besides much shipping. The Deep Mines Company in Lake County shipped an average of 7,500 tons per month of silver-lead-zinc sulphide ores, and the Climax Molybdenum Company mined and milled an average of 800 tons daily. This company will enlarge its work during 1928. The Wellington Mines Company in Summit County produced an average of 110 tons daily during the period of operations. Park County should show unusual mining progress during 1928, judging from the extent of development work that is under way and the amount of gold ore in sight. In Mineral County, the Wagon Wheel Gap mine has produced an average of 500 tons per month of fluorspar, which has been purchased regularly by the Colorado Fuel & Iron Company for use at its steel mills. The Little Annie mine, in Rio Grande County, made one of the richest strikes of the year, just before the heavy snows started. The Rifle plant of the United States Vanadium Company, in Garfield County, is producing and milling 3,500 tons per month of vanadium-bearing ore. The mill capacity has been increased to take care of additional ore developed. The Akron mine in Gunnison County expects to increase shipments, having curtailed its shipments to 150 tons per month while undergoing repairs and improvements. It has a heavy lead-silver-zinc ore.

Mr. Henahen, who is also inspector for district No. 4, comprising Dolores, Hinsdale, San Miguel, San Juan, La Plata and Ouray counties, says that improved processes have brought many of the camps out of oblivion. The International Smelting Company's 225-ton custom concentration and flotation plant at Rico has been an incentive to mining operations in that section. Mills are needed in other sections of his district, and it is expected that several will soon be erected. Attention is being attracted to the lode mining in San Miguel County, where development operations have disclosed considerable commercial ore.

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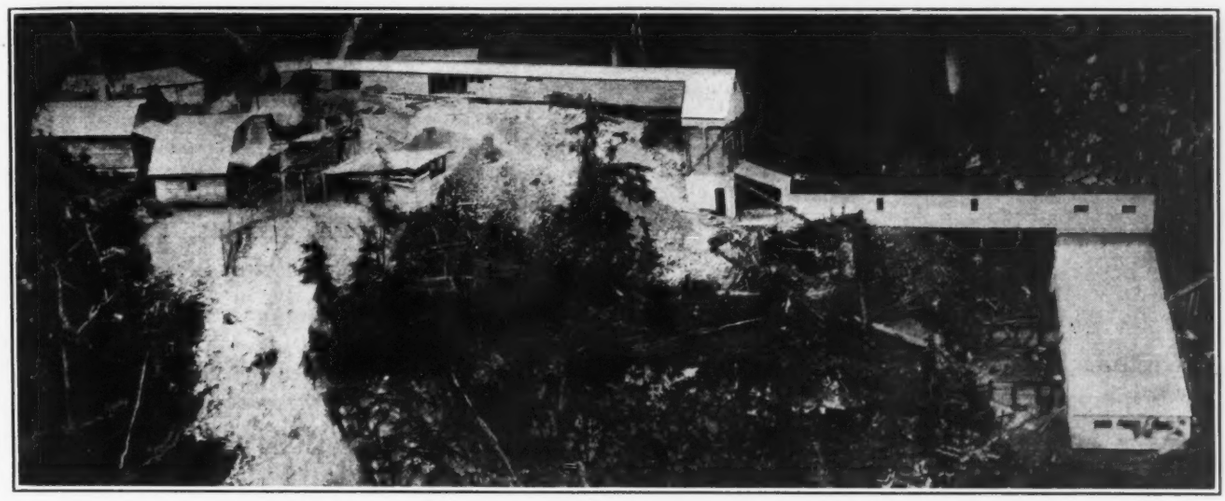
Frisco Mill, Near Bingham, Destroyed by Fire

The old Frisco mill, situated near the Highland Boy mine of the Utah Delaware Mining Company, at Bingham, Utah, was recently destroyed by fire. Along with the old plant—abandoned and partially dismantled seven years ago—the home of R. J. Bryant, superintendent of the Utah Metal and Tunnel Company, two other homes, and the change house were also destroyed. Deep snow on the roofs of twenty-five nearby houses prevented these buildings from catching afire.

New Mill of Toric Company to Operate in Spring

Expect to Treat 2,700 Tons of Silver-Gold Ore a Month by June—Will Install More Power Equipment

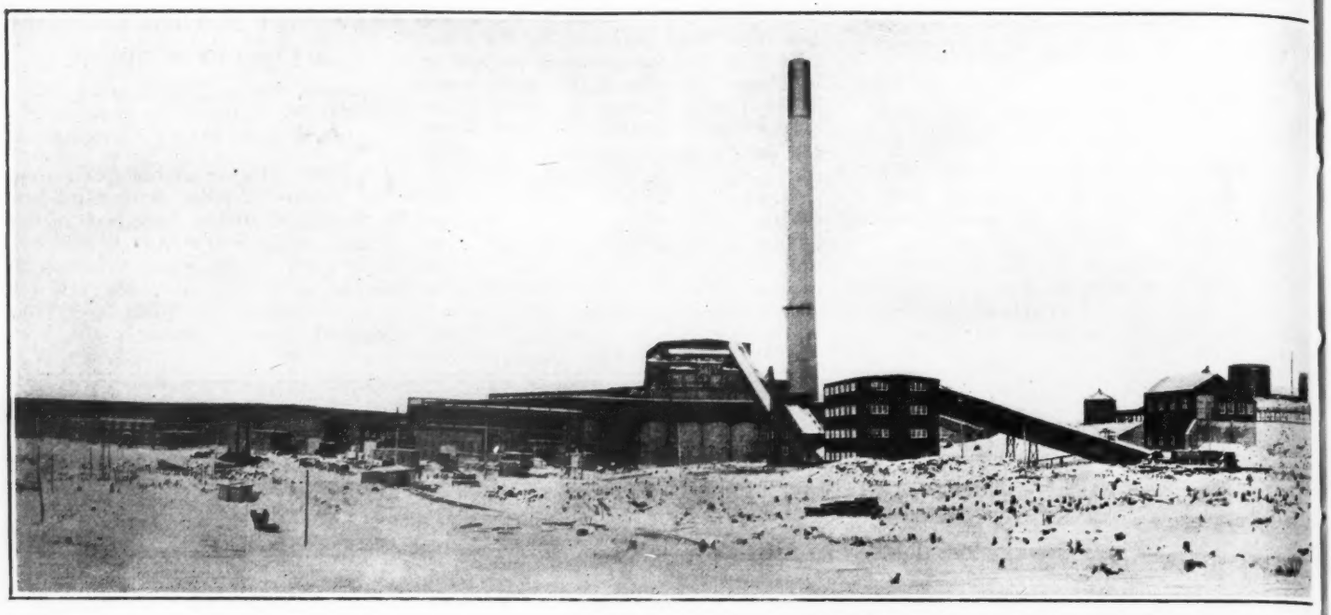
OPERATIONS at the Toric mine, situated 17 miles above Alice Arm, in British Columbia, have been discontinued, except for a little development by a small winter force, to await the coming of spring, when the new mill is to be started. According to A. C. H. Gerhardi, general manager for Toric Mines Company, Ltd., the operating company, the mill should be handling about 2,700 tons of silver-gold ore per month by next June. The average value of the mill ore at current prices for silver is said to be $12 per ton, with the silver predominating. Ore reserves are estimated in the last annual report at 610,000 tons, of which 400,000 tons is reasonably assured.



New Mill of Toric Mines Company, Ltd., near Alice Arm, British Columbia

The mill, shown in the accompanying illustration, is equipped with a jaw crusher, a set of 30- by 14-in. rolls, a Hardinge ball mill, an amalgamator, and Wilfley tables. Four McIntosh flotation cells are to be installed as soon as roads can be broken in the spring. Tests on the ore made by the Minerals Separation Company and the Dominion Department of Mines show that after the coarse gold has been removed by amalgamation, and the coarse silver by tabling on Wilfleys, an excellent tailing can be made by flotation. The silver in the ore occurs chiefly as "native" and in argentite, and the gold is free. About 3 per cent of lead is also contained, and the saving of this is a factor in the decision to use concentration rather than a combination of amalgamation and cyaniding. A ten-day trial run of the plant last fall showed that the equipment is in good condition.

Mr. Gerhardi is now on his way to London, where he will place orders for a second unit of the Diesel-electric plant that supplies power for the mill. This will consist of a 120-hp. engine and a 75-kw. generator.



Smelting plant of Noranda Mines, Ltd.,

The various structures, from left to right, are: power house and warehouses,

Noranda Smelting Plant Operates Smoothly

Substantial Savings in Flux and Fuel Indicated—To Start Construction of 500-Ton Concentrator

THE Noranda smelter, which was blown in on Dec. 13, is operating more smoothly than might be expected of a new plant. Although officials are not yet in a position to make definite statements concerning the efficiency of the plant, preliminary operations indicate a substantial saving over estimates, in both flux and fuel. The saving in fuel is to be credited in a large degree to the use of a recuperator which utilizes the heat from the waste furnace gases to heat the air used in burning the fuel. This will help to reduce costs, as the price of coal landed on the property is high, and the reduction in the estimated amount of flux necessary will increase the amount of copper in the charge. It is also believed that the estimated capacity of 500 tons a day for each unit will eventually be considerably exceeded.

Now that the plant is in actual operation, various estimates of possible profits are being made. It is expected that the ore will average 10 per cent copper and from $5 to $6 in gold. Smelter losses are not expected to exceed one-half of 1 per cent copper, so the recovery should be 9½ per cent or 190 lb., which at 13½c. has a value of $25.65 and, including the gold, a total recoverable value of $31. Mining and smelting costs are estimated at $8, and freight, refining, and marketing at $5, leaving an estimated profit of $18 per ton. If these profits are realized it should be possible, in the first year's operations of only one unit, to earn sufficient to retire the $3,000,000 bonds outstanding and still leave a surplus.

The company has decided to start immediately the construction of a 500-ton concentrator, which will adjoin the smelter, and which will utilize the present crushing and sampling plant. A. E. Wheeler, who designed the smelter, is now finishing the plans for the concentrator. The Canadian Bridge Company has the contract to supply the steel framework for the building, and orders have already been placed for part of the machinery. The mill, which should be operating by next summer, will be used to concentrate the lower-grade ores from the Horne and Waite mines. No decision has yet been reached as to the building of a concentrator at the Aldermac, and it is believed that several months' additional development work will be done before a decision is made.

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Texas Gulf Sulphur Plans Extensive Operations

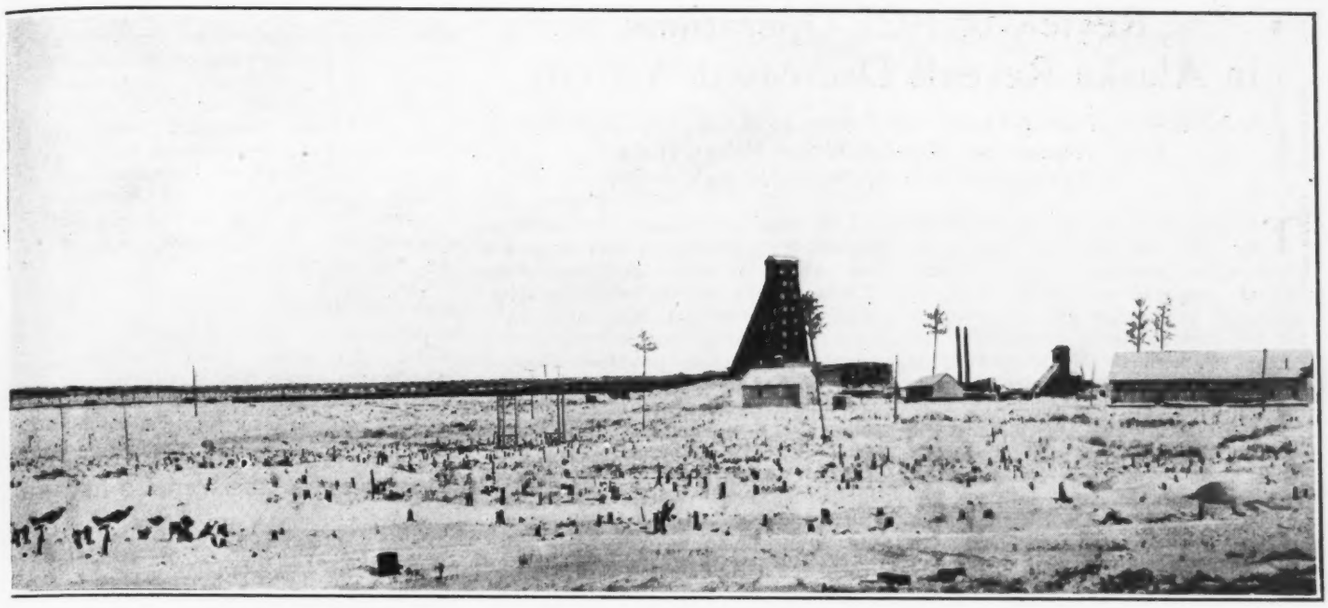
In acquiring the sulphur and surface rights to more than 500 acres of land situated near Boling, Wharton County, Tex., for a cash consideration of nearly $1,000,000, the Texas Gulf Sulphur Company has placed itself in position to greatly enlarge its sulphur production operations. The company has been making tests of the sulphur deposit for some time and its proved potential tonnage is said to be the largest so far discovered on the Gulf Coast. Plans for a production plant, which will exceed all others of its kind in size and capacity, are now being prepared, and it is expected that everything will be in readiness for starting mining operations within the next few months. The largest purchase made from any single landowner by the company was the sulphur and surface rights of 240 acres of land owned by William Banker, the amount being $500,000. Mr. Banker retained the oil rights and a fractional royalty on sulphur production.

Accidents Decrease in Arizona Operations

Phelps Dodge Statistics Show Reduction of 50 Per Cent—Belmont Copper Encounters Another Vein

AT THE regular quarterly meeting of the safety committee of the Phelps Dodge Corporation recently held in the office of P. G. Beckett at Douglas, Ariz., it was disclosed that the number of mine accidents at the various branches of the corporation during 1927 were reduced approximately 50 per cent as compared with the figures for the previous year. Since safety and accident prevention work of the corporation was reorganized in 1925, the accident rate among the various branches has been constantly reduced. The accident rate for the first eleven months of 1927 shows a reduction of 45.2 per cent over the rate for the corresponding period of the previous year, a reduction of 80.2 per cent over the first eleven months of 1925, and 88.1 per cent over the same period of 1924. Indications are that the James Douglas memorial safety trophy, awarded to the branch having the best accident record for the year, will be won by the Moctezuma Copper Company of Nacozari, Mexico. This company has been a consistent leader throughout the safety contest which has been conducted during the year, and, with the exception of one or two months, has been at the top of the list for the minimum number of lost-time accidents.

In the course of easterly operations toward the Grand Pacific claims, the drift on the 1,450-ft. level of the Belmont Copper Company's property at Superior, Ariz., encountered a 4-in streak of chalcopyrite, about 800 ft. from the shaft. The drift cut through the vein, which was about 18 ft. wide,



in the Rouyn district of Quebec

smelter, secondary crusher, primary crusher, new main shaft, and old shaft

and it was on the footwall side of the vein that the streak occurred. The rest of the vein is also mineralized, containing iron, copper, and some silver. Experiments carried out by several engineering firms show that the silver ores of the property lend themselves readily to flotation, and that about 92 to 96 per cent of the values can be recovered. The ore merely requires fine crushing, classification, and selective flotation. It is planned to construct a small plant, which will handle 25 tons in eight hours, in the near future, and the silver ore already blocked out on the 1,000, 1,100, and 1,400 levels will then be treated before being sent to the lead smelter in Douglas.

The new No. 5 shaft of the Magma Copper Company had been just holed through when the fire in No. 3 shaft occurred. The work has since been rushed to completion, so that this new shaft may be put into operation as a hoisting shaft, while No. 3 is being re-timbered from the 1,600 down. Although the tonnage output may be low for the last month, nevertheless the decreased production will be made up during the quarter.

The Helmet Peak Mining and Milling Company has started development of its property in Pima County. Control of 17 claims, which have been developed by 3,000 feet of drifts on various levels, is held by the company. The mine is said to have 1,000,000 tons of commercial ore in sight. No. 1, or the main working shaft, is being deepened from the 400- to the 600-ft. level. No. 2 and No. 3 shafts have been sunk to the 100-ft. level, and are to be carried down to a depth of 250 ft. The first 50-ton unit of a 100-ton mill is being erected. While the mill is being constructed, the ore produced by the mine will be hauled to the Minerals and Metals Company's mill at Sahuarita, seven miles away.

Record Output at Mohawk, in Michigan

Production of 22,000,000 lb. of Refined Copper Largest in History of Mine —Seneca Still Closed

MOHAWK, in the Michigan copper district, produced 22,000,000 lb. of refined copper in 1927, the largest output in the company's history. No. 6 shaft continues rich in the bottom levels, and rock of good grade is coming from No. 4. The north end of the property, contiguous to No. 1, has shown an improvement in recent months, and No. 1, with close selection, can break even on 14c. copper. Considerable good copper rock remains in No. 5, and there is a possibility that this shaft may be reopened this year.

There is no confirmation of the report that Seneca is considering refinancing. The property is in good condition for reopening, if such a decision is made. Pumps have been operating continuously since the shut down. The belief is expressed that Seneca could make good on 14c. copper, providing it could start with a "clean sheet." With a favorable labor situation, no difficulty would be experienced in building up an efficient working organization within a short time. Seneca's costs were $2.75 per ton of copper rock, including mining, development, milling and transportation. Of this amount, $1.80 represented mining and development; 70c., milling; and 25c., transportation. Costs no doubt could be cut considerably, for less shaft sinking and other "dead" work would be necessary upon resumption of operations. Sinking of No. 2 Gratiot contributed largely to costs in the last year or two that Seneca was open. Physically, Seneca is regarded favorably. No. 1 shaft, sunk to the 9 level, has better copper ground at depth than elsewhere in the shaft. No. 2 is well opened on both sides between the 13 and 17 levels, and No. 3 is developed on two levels from the 11 to the 13. No. 1 is extensively opened by long drifts from the 3 level to the 8, inclusive.

Calumet & Hecla Consolidated and its subsidiary, Isle Royale, are employing in excess of 5,000 men, the largest total since 1921. The number employed by Isle Royale at mine and mill is 450. Isle Royale production is approximately 1,000,000 lb. of refined copper a month.

With the construction of a sub-station at the 81 level of No. 4 shaft, electrical installation in the Conglomerate department of Calumet & Hecla Consolidated is about completed. It will furnish power for hoisting, tramming and pumping. Electrification has been carried out generally at mines, mills and smelters during the last few years, contributing considerably to increased efficiency and lower costs in the district.

Calumet & Hecla Consolidated has stopped work in the crosscut from the 410 level of No. 2 shaft, in which an amygdaloid vein carrying copper values was opened. The men engaged in this work have been transferred to Ahmeek.

Copper is moving briskly by rail out of the Michigan district, principally to mid-west points. During the closing days of lake navigation in December, a total of 7,668,000 lb. was shipped by boat, 6,020,000 from the Calumet & Hecla docks at Lake Linden and 1,648,000 from the Copper Range docks at Houghton.

Isle Royale continues to smelt its mineral at the Michigan smelter, at Houghton. This arrangement has been in force since work was started on the modernization of Calumet & Hecla Consolidated's plant at Hubbell.

Review of 1927 Operations in Alaska Reveals Decreased Activity

Reduction in Mineral Output of Territory About $3,000,000— Less Mining and Lower Metal Prices Held Responsible for Marked Decline

THE mineral production of Alaska for 1927 will probably show a decline in total valuation of about $3,000,000 as compared with 1926, owing to decreased production and lower prices for the various metals, particularly for copper. A summary of the chief operations of the year and the developments in the different districts follows:

Placer Operations—Approximately 60 per cent of the placer gold production comes from dredges. Over 30 plants were in operation. At Nome there was a drop of about $400,000 in the year's placer gold production, attributed to a short season following a late spring and early fall, with unusual difficulty in thawing frozen ground. Two of the three dredges operated by the Hammon Consolidated Goldfields Company lost from 30 to 40 days in moving to new ground. Total production at Nome was about $1,206,600 as compared with $1,603,703 for 1926. A dry season and shortage of water reduced the output of all camps on the upper Yukon. Fairbanks, Iditarod, and McKinley placers all reported a good season. New dredging plants operated on Nome, Fish and American creeks. The Fairbanks Exploration Company's development progressed to the point where little, excepting the Cleary Dome tunnel, remains to be done to complete the 100-mile ditch line from Chatanika. This will be finished by early spring. The line includes seven miles of siphon pipe. The 5,000-hp. plant is practically completed at a cost of around $1,000,000. The machinery for the company's first two dredges, which aggregates 3,000 tons, is being transported to the sites of preliminary operations. The two dredges will be ready for operation in the early summer of 1928, when a big jump in gold production is expected. The Tanana Valley Gold Dredging Company, of London, England, proposes the installation of a second dredge on Fish River, and is testing Engineer Creek with a similar object in view. Another English company is drilling Sullivan and Kokomo creeks. Lewisohn interests have acquired options on Fish, Ester, and Fairbanks creeks. The Hecla Mining Company of Idaho has expended $300,000 in the past three years in drilling Parkins ground on Birch Creek, at Circle, and is arranging to send in between 600 and 700 tons of dredging machinery to be hauled by tractors from Chatanika station on the Alaska Railway to the site of operations, a distance of 126 miles. The New York Alaska Gold Dredging Company is arranging to install a hydraulic plant on Bear Creek, a tributary of Tulaksak River. During the year new placer discoveries were made at Ophir, Valdez Creek, Noatak, and Kotzebue.

Lode gold operations—The outstanding feature of the year's operations was the completion of the additions to the Alaska Juneau mill to bring the treatment capacity up to 12,000 tons a day—the largest gold milling enterprise in the world. This mine produces about a third of the entire gold output of the Territory. Construction of new milling plants were completed during the year at Little Susitna River by the Marion Twin Mining Company; at the Ethel Mine at Valdez; at Port Wells; at the Jacob Marty mine; at Windham; and at Kassan Bay. The Tanana Valley Gold Dredging Company has made the second payment on the Ryan Lode mine, where it proposes to build a large mill and power plant. Marion Twin Mining Company proposes installing a new mill on Craigie Creek. During the year, new strikes of gold-quartz were reported from Nabesna, Valdez Creek, Golconda Creek, Indian River, and the Meegan Mine. The old Haley mine at Chichagoff is being reopened; the Granite mill has been enlarged; the Fera Gold Mining Company is increasing its milling plant to a capacity of 300 tons a day and arranging to construct a hydro-electric plant to permit all-year operation. The year was notable for the attention paid by investors to the possibilities of developing gold-quartz mines, particularly at Nome and Fairbanks.

Silver operations—The silver production of Alaska comes mainly from the Alaska Juneau gold and the copper mines. The Riverside mine at Hyder was a shipper of silver ores during the summer. A galena mine at Skagway is being equipped for operation. New strikes of galena are reported from Chichagoff, North Wrangell, Kantishna, and Copper River.

Copper operations—Copper represents the greatest value of any metal mineral produced in Alaska. The producers are the Bonanza, Jumbo, Erie, and Mother Lode mines, on Copper River, and the Beatson, on Latouche Island, all of which are controlled by the Kennecott Copper Company. Mother Lode production dropped to 12,151,000 lb. copper for the first half of the year as compared with 14,553,000 lb. for the corresponding period of 1926. The Copper Creek Mines Company, which owns the Orange Hill copper property on Copper River, is engaged in the active development of what promises to be another large copper producer. Extensive diamond drilling has given satisfactory results, and the mine is now being opened to depth by a shaft. About 100 tons of machinery and supplies is being freighted to the mine this winter, and the management announces development plans involving an expenditure of approximately $2,000,000.

Minor metal operations—Tin production increased about 400 per cent for the year. A deposit of tungsten was developed in the Riverside mine. Nickel was discovered at Kodiak in a vein 42 ft. wide. Platinum has been found at Good News Bay. Antimony is being developed on Cleveland Peninsula, and a large deposit of stibnite at Kantishna is under investigation by an English company with a view to the construction of a reduction plant.

Non-metallic operations—The Vermont Marble Company opened a new marble mine at Tokeen, Prince of Wales Island. At Kobuc River, Berryman and Hansen mined 400 lb. of jade for requirements of American jewelers. Asbestos was found on Kotzebue Sound.

Another Quicksilver Camp Established in Texas

Another quicksilver camp has been established in the Big Bend region, at a point about 75 miles south of Marathon, Tex., and the same distance from the railroad. The new mine is being operated by W. D. Burcham, who has a store at Glenn Springs on the Rio Grande. He is mining considerable quantities of cinnabar ore and he plans to keep the furnace at the mine in constant operation. The location of this mine is approximately fifty miles east of the Terlingua quicksilver district, where production of the metal has been in progress for many years. At Terlingua, the Chisos Mining Company, which operates the largest mine, is producing and shipping approximately six hundred flasks of quicksilver a month. The heavy metal is hauled from Terlingua to Marathon, 90 miles, in wagons drawn by mules, there being twelve mules to each wagon.

Silver Reef Consolidated Properties Purchased

Properties of the Silver Reef Consolidated Mines Company in Washington County, near St. George, Utah, were purchased in December at a receiver's sale by Samuel I. Silverman of New York City for $100,000. The buyer contracted to proceed immediately with the development of the property. The International Smelting Company was the only other bidder.

Under the direction of Alex Colbath, now in charge for the Silverman interests, a large tonnage of low-grade silver ore, left in the course of early operations and opened up in virgin ground along the reef, has been made available. A mill, employing some form of leaching, is to be erected at once.

Schlumberger Company Completes Electrical Survey

Schlumberger Electrical Prospecting Methods recently completed a survey of a 1,300-acre property on Cape Breton Island for the Consolidated Mining and Smelting Company of Canada, Ltd.

Toronto Letter

By Our Special Correspondent for Northern Ontario

Widespread Public Interest in the Mining Market During Last Year

TORONTO, DEC. 31—In reviewing Ontario mining in the last year one of the most interesting phases has been the extent of the public participation in the mining market. Although much of the activity was unwarranted, it does indicate the growing and more widespread public interest. During the first eleven months of 1927, on the listed department of the Standard Mining Exchange of Toronto alone, 260,000,000 shares were traded in. The outstanding stock was Amulet, which was traded in to the extent of 20,500,000 shares, or ten times its issued capital, with a value of $32,131,000. Noranda was second in value, with $30,659,000. Teck-Hughes came next, with 4,000,000 shares, valued at $26,415,254; then Wright-Hargreaves, with 2,446,596 shares, valued at $18,870,000; and Kirkland Lake Gold, 8,463,000 shares, valued at $15,225,000. Other stocks in which there was very active trading were Barry Hollinger, 15,404,000 shares; Laval-Quebec, 14,513,000; Area, 13,007,000; Argonaut, 11,374,000; and Tough-Oakes, 11,090,000. Of the stocks listed on the exchange, 47 were traded in during the eleven months to the extent of more than 1,000,000 shares; 33 in excess of 2,000,000 shares; 23 in excess of 3,000,000 shares; and for 16 stocks the volume traded was over 5,000,000 shares each.

WRIGHT-HARGREAVES has cut its north vein on the 1,750 level, where it shows a width of about 6 ft. The shaft is being continued to the 2,000 level, and four new levels from 1,625 to 2,000 ft. will then be opened up. This vein is being developed on the 1,500 level near the Lake Shore boundary, where some high-grade ore has been found. A good deal of this work has been in a faulted zone, and it is believed that with greater depth more continuous ore will be found. The mill is handling over 700 tons a day of an average grade of between $10 and $11. The grade is down somewhat from that of recent months, because of the large amount of development rock going to the mill.

Accompanying the warrants giving Nipissing shareholders the opportunity of buying Robb-Montbray shares at 30c., which right expires on Jan. 25, there is a report on the property by Hugh Park, general manager of the Nipissing, which is the first official detailed statement to be issued. He recounts the discovery of three surface showings, No. 1 and No. 2 consisting of schisted and brecciated rhyolite in which occur shoots of comparatively small length and width giving low but encouraging values in copper and gold. On the No. 1 deposit good gold and copper assays were obtained over a width of 20 ft. Deposit No. 2 does not show quite as good grade as No. 1, but diamond drilling indicates a pear-shaped copper-gold deposit 80 ft. deep, having a width of 50 ft. at the bottom. Surrounding this occurrence are masses of low-grade sulphides. Late in the fall of 1926, the most promising discovery, No. 3, was made, the first showing consisting of 3 ft. of chalcopyrite assaying high in gold and copper. The most important outcrop is 125 ft. from this discovery. It yielded good assays over a length of 30 ft. and a width of 9½ ft. Diamond drilling was done vertically under these two surface outcrops, and 41 in. of good ore was encountered at a depth of 50 ft., 40 in. at 80 ft., 20 in. at 100 ft., and 102 in. at 165 ft. Under the second discovery two holes cut good ore at 60 and 165 ft., giving widths of 23 and 69 in. respectively. A shaft was then sunk, and levels were opened at 125 and 225 ft., from which approximately 1,500 ft. of lateral work has been done. Results to date have been erratic, and, although high assays have been obtained, the shoots seldom exceed 15 ft. in length. Raises from the 125 level were started vertically below the two best surface exposures, but to date the raises have not shown values corresponding with the results of either the surface work or that on the levels. Present underground operations are largely confined to checking up various diamond drill results, which indicated disconnected occurrences, with gold as the most important metal. Underground work has not of course been completed, but mineralization on both levels has been spotty, and, notwithstanding the high assays obtained, the shoots encountered contain only a limited tonnage.

It is officially announced that a new company, to be known as the United Mineral Lands Corporation, has been formed to take over the Premier Paymaster and the former United Mineral Lands Company, in Porcupine. These two properties are controlled by the same interests, and the orebody which it is proposed to work runs from the Paymaster into the adjoining United Mineral Lands. It is also stated that the company has as an objective the milling of 3,000 tons a day by 1929. During recent months, the present small cyanide mill has been handling 200 to 300 tons a day of ore having an average grade of between $2 and $3. A 1,500-ton concentrator is being built, to be completed early in 1928, and, as soon as this is completed, it is proposed to start work on a second 1,500-ton unit, the concentrates to be treated in the present cyanide plant.

Bidgood property, in the eastern section of the Kirkland camp, has cut its ore on the 400 level. About 50 ft. in length has been opened up, showing a width of 6 ft. Assay returns are not yet available, but the general appearance of the ore is the same as that on the level above.

London Letter

BY W. A. DOMAN
Special Correspondent

Rhodesian Congo Border Not to Develop Discoveries Thoroughly Now

LONDON, DEC. 24—At the recent meeting of shareholders of the Rhodesian Congo Border Concession, Francis L. Gibbs, chairman, stated that the concession is so extensive that it would be quite beyond the financial resources of the company to do enough work on each discovery to determine immediately whether or not the surface indications really justified the opinion that the particular discovery was of importance. Unless new discoveries are really of outstanding importance, the board prefers to come to some conclusion before announcing them. The policy of the board is not to spend money on the thorough development of discoveries at present, but rather for the period of the concession to make as many discoveries as possible, which may later be examined more carefully with a view to determining their value. The airplane survey has covered about 20,000 square miles, and the photographs taken are now being examined.

THE fall in the price of platinum from £22 to under £14 between January and June last decidedly upset the market, but since then matters have picked up a little. The South African platinum deposits have not been developed so rapidly as had been hoped, and London, which previously was the principal market for the metal, has been displaced by Berlin for Europe, by New York for America, and by Tokyo for the Far East. Of the estimated actual world consumption of 160,000 to 170,000 oz. it is estimated that Russia alone has supplied this year about 100,000 oz.

As regards nitrate, J. O. Herrera, the chairman of the Pan de Azucar Nitrate Company, at the annual meeting several days ago, criticized the reversion to free selling. The great majority of producers, he said, who voted for the suspension of the pooling arrangement, were undoubtedly familiar with the very serious disadvantages of free selling, but presumably they considered that prevailing circumstances made it preferable for them to gain their liberty to sell independently. In the past, free selling proved a failure, on account of the speculation which was induced, and it is regrettable that the industry will again have to undergo a period of depression in order that the producers may realize once more than they must come together and re-establish some kind of union. It has been pointed out in various quarters that a cartel for the entire nitrogen industry of the world might be organized which would be of material advantage to all interests concerned.

Mexico City Letter

By W. L. Vail
Special Correspondent

Proposed Labor Law, Passed by Senate, Is Defeated in the Lower House

Mexico City, Dec. 29—The proposed new Mexican labor law, drafted by the senate and passed in that body, has been defeated in the lower house, and unless some extraneous pressure is brought to bear in the few remaining days of this Congress, it will not be reconsidered until the following session next September. The mining interests are generally pleased. The president sent to the lower house on Dec. 26 the draft of a law modifying Articles 14 and 15 of the petroleum regulations, as a result of a recent decision in the supreme court adverse to these sections of the regulations. The proposition was given right of way, and unanimously passed the next day. As a result the chamber of mines asks for a modification of Article 48 of the mining laws, which would confirm coal rights on lands acquired prior to the constitution of 1917, and asks that the Congress take the same action just taken in reference to Articles 14 and 15 of the petroleum regulations. The above action by Congress is generally accepted as the beginning of the end of the long struggle between the government and the oil men, and the dawn of better times in Mexico.

THE federal labor board, sitting in the City of Mexico, has decided 48 complaints out of 108 presented since the organization of the board, on Nov. 1, 1926. Forty-six claims are now under advisement, and 14 remain to be considered. One of the important decisions was given against a group of workmen claiming a sum of money for overtime work. The decision was to the effect that as the constitution of Mexico does not permit more than one hour overtime beyond the legal eight hours daily, and that only three times a week, the complainants had no legal recourse. The decision was extremely important because similar action was intended in a number of camps, had the board decided favorably for the workmen.

The new governor of the State of Nuevo Leon, Aron Saenz, formerly Secretary of Foreign Relations, is taking an active interest in promoting mining and other industries in his state. New industries entering the state are granted a 50 per cent reduction on local taxation for twenty years. Provisions are also made for a reduction of taxes on all industries which increase their output or extend their lines of operation.

A recent statement of labor conditions contains the following information relative to the average wages paid miners in a few of the principal mining states: Northern Sonora, 5.27 pesos daily; Chihuahua, 4; Coahuila, 2.85; Lower California, 3.45; Guanajuato, 1.66; Jalisco, 2.07; Zacatecas, 2.88; Hidalgo, 3.00; Oaxaca, 1.68; Michoacan, 2.10; Guerrero, 1.64, and State of Mexico, 1.65. There has been a slight advance of wages in some camps. It is difficult, however, to strike a really fair average, because conditions of living differ so widely in different parts of the country. In most of the large camps wages remain about the same as a year ago.

The Matulera mine, in the district of Ocampo, State of Chihuahua, reopened on Dec. 1, with 300 men at work, after being shut down since 1911 because of unsettled conditions in that section of the state. On Jan. 10 500 more men were added to the payroll. A small mill is being completed at San Ramon for handling the ores. The Matulera was at one time one of the most important silver mines in the Ocampo district.

In the project for extending automobile roads for the year 1928, a 100-km. highway is contemplated from Pachuca, Hidalgo, to Rosario, in the State of Mexico, primarily for the purpose of opening up a rich mineral section which has been lying idle for the past quarter of a century. Work on the new road is to start in February, and it is presumed that it will be completed before the end of the year.

The War Department has just issued a book of new regulations regarding the purchase, sale, and transportation of explosives, ammunition, and firearms, which is of particular interest to mine operators.

The Majestic Mining Company, at Totolapan, Oaxaca, has resumed work on a small scale following a temporary shutdown for the purpose of installing new equipment.

For the week ended Dec. 27, 156 carloads of zinc ores, 86 of refined lead, 3 of arsenic, and 1 carload of antimony were shipped from the port of Tampico.

Machinery for the new plant at the Socavon de San Fernando mine is being installed, and the new plant is expected to be in operation by the middle of February.

Hecla Mining Company to Extend Main Shaft

The Hecla Mining Company, of Wallace, Idaho, is adding 800 ft. to the depth of its main shaft, which now has a vertical depth of 2,000 ft. from the surface. There is no element of chance in this undertaking, as the Hecla orebody has been proved and developed to the additional depth. This was accomplished by sinking a winze from the 2,000 level at a point about 1,600 ft. east of the main shaft. From this winze the ore has been developed on the 2,400 and 2,800 levels, on both of which levels the ore maintains its usual lead-silver values, as well as its length of about 1,800 ft. and average width of 10 to 12 ft. There are also large ore reserves above the 2,000 level.

Johannesburg Letter

By John Watson
Special Correspondent

Union Department of Mines Issues More Statistics of Mineral Output

Johannesburg, Dec. 3. — Statistics issued recently by the Union Department of Mines give the following figures for the month of October and for the first ten months of 1927:

	Month of October	First Ten Months of 1927
Gold	£3,622,071	£35,809,433
Silver	9,827	98,455
Osmiridium	4,210	46,106
Platinum	4,781	123,170
Diamonds	920,936	10,536,326
Coal	319,455	3,201,164
Copper	61,645	471,716
Tin	23,596	281,660
Other minerals	39,168	399,021
Total value	£5,005,689	£50,967,051

The Transvaal Chamber of Mines monthly analysis for October shows that the output of the gold mines for the first ten months of 1927 totaled £35,326,045 in value, an increase of £628,629 over the record for the corresponding period of 1926. The "outside" mines, chiefly represented by the Sub Nigel property, have shown the most remarkable improvement; this year's yield has averaged 12.680 dwt. per ton milled, and, despite an increase of 7d. per ton in working costs, the profit per ton has practically doubled—from 10s. 5d. in 1926, to 20s. 9d. per ton in the first ten months of 1927.

THE precious stones act has produced a crisis on the Barkly West and Similore diamond diggings, as it forbids diggers on alluvial fields to enter into partnership with others, whether diggers or not. Up to date diggers have often been supported by diamond buyers, who gave them financial backing. Since Nov. 17, when the new act came into force, this practice became illegal. A meeting of diggers in Barkly West district recently passed a resolution demanding that the minister of mines investigate the conditions, personally, and grant some relief; otherwise many white men and about 2,000 natives will be thrown out of work.

H. B. Butler, deputy director of the International Labor Bureau at Geneva, who is now in South Africa, has suggested calling a conference of experts on silicosis, to be held in Johannesburg. Sir Spencer Lister, director of the South African Institute of Medical Research, considers that Johannesburg would be the most suitable meeting place for such a conference.

On Nov. 28 an inquiry was opened at the Crown Mines into the accident that occurred in that mine on Nov. 16, when P. J. du Toit and eleven natives lost their lives by a fall of rock. C. J. Gray, mining inspector, and Dr. Glover, health magistrate for inquests, held the inquiry.

Societies, Addresses, Reports

Economic Geologists and Geological Society Hold Joint Session at Cleveland

THE Society of Economic Geologists met in joint session with the Geological Society of America, Dec. 29-31, 1927, at Western Reserve University and Case School of Applied Science, Cleveland, Ohio.

The subject of the presidential address, by Frederick L. Ransome, the retiring president, was "Directions of Progress in Economic Geology." The theories of ore deposits that connect most of them intimately with igneous activities have become even more firmly intrenched by the studies of recent years. It is doubtful, however, in the speaker's opinion, whether the terms "veindike" and "magmation" stand for conceptions that have contributed to real progress. In many cases also there are reasons for serious doubt on these theories as in the case of many lead and zinc ores which are not obviously connected with any igneous rock, and the problem of origin of gold veins in the Tertiary igneous rocks. At Jerome also it is not obvious which magma has contributed the ores.

Among the noteworthy advances were named William H. Emmons' studies on the zoning of metalliferous ores and the work of Augustus Locke and associates on gossans. Under the head of technique the geophysical methods have definitely emerged from the status of the "wigglestick," and micropaleontology has made great progress in many oil regions.

On the other hand, progress has been retarded along many lines by the lack of fundamental chemical and physical data. There is still too much conjecture. For example, we do not yet know the behavior of silica and the metallic sulphides at high temperatures and pressures nor the nature of solutions that carry the sulphide ores. Other problems include the capacity of solvents, the processes of deposition, the replacement of earlier by later minerals, and the relations of sulphide enrichment to ground waters.

The Society of Economic Geologists is a scientific society, not a technical or industrial one. Its function is to keep its members in touch with the science of geology and to obtain from them contributions to its literature so that they will not be mere users, drawing constantly upon its capital but adding nothing. The economic geologist, first of all, must be a good geologist; but he bears a double responsibility—to his science and to his client. As a teacher he owes to his students a clear statement of the doubts and uncertainties that still confront us.

Waldemar Lindgren presented a paper on "The Ores of Potosi, Bolivia." Potosi was compared with Cripple Creek —the veins contracting downward and spreading above. The metals are silver and tin, the silver decreasing downward. The veins are dark, massive, sharply defined, and frozen to the walls, which are rhyolite porphyry, somewhat silicified. Hypogene alunite occurs throughout the altered rock and some in the ore, which is a combined filling and replacement of broken rock. Besides cassiterite, stannite is also abundant, especially in the lower levels. Most of the silver is carried by the tetrahedrite. The composition and history of the ore can be made out only by the use of the metallographic microscope. Probably there has been no secondary enrichment.

Henry G. Ferguson discussed the "Age and Distribution of Nevada's Ore Deposits." Deep seated gold quartz veins are connected with satellitic granite batholiths associated with the great Sierra batholith, of post-Jurassic age. These deposits are nearly barren of the base metals. In contrast, the Rocky Mountain granites, probably of Eocene age, as in Utah, have produced copper, lead, and zinc ores, with silver and gold; and near-surface veins are associated with Tertiary lavas.

Discussing "Origin of the Pre-Cambrian Banded Iron Formations," Elwood S. Moore described laboratory experiments which show that organic matter in water helps to hold both iron and silica in solution, serving as a protective colloid for both, and that carbon dioxide increases the solution of iron. The iron precipitates quickly, in three days for ordinary river waters; the silica very slowly, requiring several months—hence the banding. The silica becomes granular and iron oxide coats the particles.

Thomas M. Broderick described "Results of Geographical Explorations in the Michigan Copper Country." Owing to the small quantity and finely disseminated character of most of the copper the difference between ore and barren rock is very slight. Various electrical and magnetic methods were tried without success.

Edward Sampson answered in the affirmative the question: "May Chromite Crystallize Late?" In banded gneissic dunite some chromite bands are like veins and may be late. In the chromitite rocks of South Africa, chromite is the dominant mineral and is distinctly interstitial between crystals of bronzite. Chromite in serpentine is not secondary, as was once supposed, but is a primary constituent of the original igneous rock.

Clarence S. Ross discussed "The Hydrothermal Origin of Chromite," suggesting such an origin for chromite associated with talc, chlorite, and authophyllite.

Gerald F. Loughlin presented "Remarks on Certain Unsatisfactory Concrete Aggregates," in which he described various limestones that withstood satisfactorily the usual crushing and weathering tests for use in concrete, but failed due to frost action in cracks and pores revealed only by the microscope.

Ransom E. Somers presented "Petrographic Criteria of Structure in the Cromwell Oilfield, Oklahoma." In the tightly cemented calcareous sandstone of the caprock the distribution of pressure-twinning in calcite and the occurrence of secondary pyrite in drill cores were in every case found closely associated with faulting or probable faulting. It is suggested that such petrographic evidence may indicate the proximity of faults.

Thomas C. Brown discussed "Climatic Conditions When Coal Beds Were Formed," before the Geological Society of America. He pointed out that most coal occurs in temperate, cold temperate, or even polar regions; that the vegetation was dry-land types, not swamp growth; that plant material now accumulates almost wholly in cool temperate regions; that rank vegetation similar to that of the coal beds grows in such regions; and that glacial or near-glacial climates prevailed before, during, or immediately after every period of extensive coal formation. His conclusion is that low temperature, preventing or retarding bacterial activity, has been the most important factor in coal formation.

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Hold Michigan Conference in Detroit, Jan. 27-28

The third Michigan Engineering Conference will be held in the Hotel Statler, Detroit, Jan. 27 and 28. The conference is an outgrowth of a movement started by the technical societies in Detroit and fostered by the Michigan Engineering Society. Representatives from various organizations, having engineering problems to deal with, act on committees during the year to further the advancement of general problems before the public, and meet once a year to listen to addresses on various topics of common interest.

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Northern California Mining Association Formed

The Northern California Mining Association was formed recently at Redding, Calif., with headquarters at the same place. The purpose of the organization is to stimulate interest in mining.

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Colorado Mining Association to Hold Annual Meeting

The Colorado Mining Association will hold its annual meeting at Denver, Jan. 19 and 20, following the last session of which the fifth annual miners' sowbelly dinner will be given.

Recent Technical Publications

"MODERN BLASTING IN QUARRIES AND OPEN PITS." By J. Barab. The Hercules Powder Company, Wilmington, Del. Pages 169. Price $3.

The powder company publishing this book says that it has endeavored to produce a comprehensive and practical reference for the quarry operator. Included among the topics treated in the 21 chapters are the following: Explosives reactions; explosives in present use and their properties; blasting accessories and their use; drills and drilling; blasting methods; open-pit copper mining; open-pit iron mining; technical records; how to increase production and lower production costs; cost reduction through accident prevention; and magazines. The book is well illustrated and in general bears witness to the truth of the publisher's statement that no expense has been spared in producing it. The company announces that it will be glad to present every operator using explosives with at least one copy.

RHODESIA MINING—The Mining Annual of the *Mining and Industrial Magazine and Rhodesian Mining Journal* has arrived. It is an ambitious issue in which the publisher has succeeded in his attempt to produce a comprehensive review of the mining industry in Southern Africa, especially Northern Rhodesia, in 1927. It is sold at 5s. a copy. It is accompanied by an 84-page pamphlet entitled "The Mining Laws of Southern Africa," a condensation of the various acts and notices governing mining in the different states and provinces. A new map of Northern Rhodesia, drawn to a scale of 42.6 miles to the inch, also accompanies the issue. In the *Annual* itself several interesting articles appear. One of these, entitled "Evolution of Rand Mining Practices," is by H. F. Marriott, former president of the Institution of Mining and Metallurgy. Several pages are devoted to a compilation of the mining companies floated in the last three years. These include 72 platinum companies and 54 diamond-mining companies. The issue concludes with a directory of miscellaneous mining companies in South Africa.

A peep into the technical future (ten years ahead) of mining on the Rand is taken in the November issue of the *Mining and Industrial Magazine.*

SAFETY—The *Transactions* of the National Safety Council, now in print, contain a report of the proceedings of the Metals Section of the Sixteenth Annual Safety Congress, held in Chicago, Sept. 6 to 30 last.

CANADA'S MINERALS—An official estimate of Canada's mineral production in 1927 has been issued by the Dominion Bureau of Statistics. The production of gold, copper, lead, zinc, cement, gypsum, and lime is reported as having been greater than in any previous year.

MINERAL STATISTICS—The Imperial Institute has issued a 356-page book entitled "The Mineral Industry of the British Empire and Foreign Countries." This is a statistical summary of the production and imports and exports of metals and minerals for the years 1924 to 1926. The price is 8s. net. The book may be obtained at H. M. Stationery Office, at Adastral House, Kingsway, London, W. C. 2, England, and in the United States at the British Library of Information, 44 Whitehall St., New York.

Another bulletin of somewhat similar nature is the "Mining Review" for the half year ended June 30, 1927, issued by the Department of Mines of South Australia. It begins with a discussion of the various conditions that must be observed in staking and working claims, to hold them under the law. The subjects of mining on private property and of search licenses are also covered. A few pages of notes on sampling and valuing prospects are added.

Still another bulletin of this sort is the quarterly publication entitled "Mining in California," issued by the California State Mining Bureau, San Francisco. This bulletin is 136 pages long. It covers production and occurrence of metals and non-metallic minerals known in the state.

ALABAMA GEOLOGY—Charles Butts is the author of the Bessemer-Vandiver Folio, which has just been published by the U. S. Geological Survey. The area covered is in the north-central part of the state, and includes the Birmingham district. Its mineral resources consist of coal, iron, dolomite and limestone, shale and clay, road metal, chert, building stone, sand, and lime and cement materials.

EMERALDS—An interview with H. S. Harger on the subject of the emerald discovery in the Northern Transvaal is given in the Dec. 3 issue of the *South African Mining and Engineering Journal.* The occurrences, which are in the Leydsdorp district, where Mr. Harger recently examined them, include genuine emeralds, in his opinion, although the majority of the stones on view rank as beryl.

MANGANESE—The position of manganese in South Africa with respect to the discoveries in the Postmasburg field is discussed in an editorial in the same issue of the publication named in the preceding paragraph.

FLOTATION—Fourteen pages are devoted to the subject of flotation in the Dec. 1 issue of *Metall und Erz,* published in Berlin. Professor Grumbrecht, of Clausthal, writes on the present position of selective flotation; Professor Madel, of Freiberg, discusses the advance made in the flotation of oxidized ores and gangue minerals; Herr Patzsche writes on "America and Flotation in Germany."

BLUEPRINTS—Thomas A. Diamond, associate professor of vocational education at the University of Michigan, has prepared a primer on blueprint reading. It consists largely of diagrams accompanied by questions which must be answered by the student. It is produced by the Bruce Publishing Company, of Milwaukee.

ALUMINUM—The aluminum industry in Japan is discussed in the Dec. 26, 1927, issue of *Commerce Reports* by Consul E. R. Dickover, Kobe.

PATENTS

MINE POST. No. 1,653,126. Dec. 20, 1927. Frank H. Schwerin, assignor to the Duff Manufacturing Company, Pittsburgh.

A mine post or jack with operating means for exerting endwise pressure against mine floor and roof and for withdrawing the jack after use.

CORE DRILL. No. 1,653,245. Dec. 20, 1927. Ralph Wilcox, assignor to Sullivan Machinery Company.

A core-cutting bit and a central core barrel, both having certain features.

ROCK DRILL. No. 1,643,268. Dec. 20, 1927. Elmer G. Gartin, assignor to Sullivan Machinery Company.

MINE TIE. No. 1,653,330. Dec. 20, 1927. R. H. Worrell, assignor to Worrell Mine Tie Manufacturing Company, Beckley, W. Va.

A steel tie for mine tracks.

ROCK DRILL. No. 1,653,373. Dec. 20, 1927. J. V. Rice, assignor to F. E. Tasker, New York.

A gasoline-operated rock drill.

ROCK-CUTTING TOOLS. No. 1,653,663. Dec. 27, 1927. Ole Rolfsen, Larvik, Norway.

A rock-cutting tool having a rotating shaft and a hub with radial arms and other features.

FURNACE. No. 1,653,681. Dec. 27, 1927. Utley Wedge, Paoli, Pa.

A furnace having a rotating annular grate with a central discharge opening for ash, also other features of construction, including a means for opening and for closing the opening in the grate center to permit and prevent discharge of ashes from above and to prevent escape of air-blast pressure through opening when closed.

CORE DRILL. No. 1,654,223. Dec. 27, 1927. J. S. Mitchell, assignor to the Sullivan Machinery Company.

A core barrel having certain features.

WOOD PRESERVATION. No. 1,654,229. Dec. 27, 1927. Bernhard Wurzschmitt, assignor to I. G. Farbenindustrie Aktiengesellschaft, Germany.

A wood-preserving composition comprising an organic nitro compound and formaldehyde.

HYDRAULIC ELEVATOR. No. 1,654,406. Dec. 27, 1927. Leicester A. Bonner, Vancouver, B. C.

An hydraulic elevator having certain features of design.

ROCK DRILL. No. 1,654,514. Dec. 27, 1927. T. R. E. Rundquist, assignor to the Sullivan Machinery Company.

A drilling machine.

Personal Notes

PHILIP D. WILSON sailed on Jan. 7 for Madeira, where he will catch a steamer for Cape Town. Mr. Wilson expects to remain for a few months in various parts of Africa.

ANDREW W. LIDDELL, formerly assistant general auditor of the Phelps Dodge Corporation, has been promoted to the position of general manager of the Phelps Dodge Mercantile Company.

HARRISON SOUDER, accompanied by Mrs. Souder, will sail from New York on Jan. 18 for Algiers. They will spend several months touring the Mediterranean countries, both in Africa and Europe.

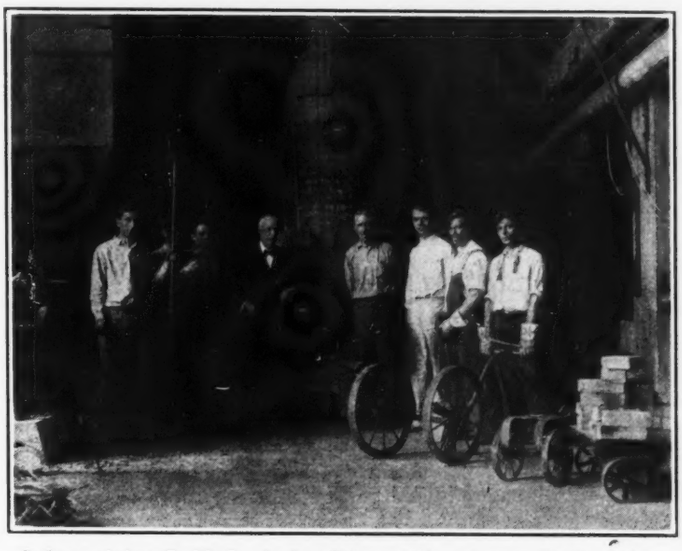
CHARLES A. MITKE is sailing for London on Jan. 21, to spend the rest of the winter on professional business in that city. Mr. Mitke's address in London will be care of Selection Trust, Ltd., Masons Ave., Coleman St., London.

A. C. H. GERHARDI, general manager of the Toric mine, in the Alice Arm district of British Columbia, was in New York last week on his way to London, where he will confer with officers and important shareholders in Toric Mines Company, Ltd.

W. H. EARDLEY, assistant manager of the United States Smelting, Refining & Mining Company, and Miss Elizabeth Kitchens, of Salt Lake City, were married on Dec. 15. Following the Christmas holidays, Mr. and Mrs. Eardley sailed for Hawaii, where they plan to spend several weeks before returning.

CHARLES D. KEADING, mining engineer, who for the past six years has been resident in San Francisco, where he was actively identified with the Newmont Mining Corporation, is removing to Toronto. He will be associated in an advisory capacity with the Anglo-Canadian Explorers, Ltd., in which British capital is largely interested.

DR. R. H. RICHARDS, who is now in his 84th year, frequently visits the laboratories of the Massachusetts Institute of Technology and keeps his interest in what is going on in mining and metallurgy. Recently he took his camera to the laboratory and the accompanying illustration was taken. It shows him with a typical group around the laboratory blast furnace.



Left to right: C. M. Loeb, Jr., Edward Hartshorne, H. L. Geiger, Dr. R. H. Richards, Prof. C. R. Hayward, L. F. Van Mater, J. F. Mulvey, F. L. Coonan

EUGENE G. GRACE, president of the Bethlehem Steel Corporation, announced on Jan. 2 a series of gold awards for progress during 1928 in eliminating human waste caused by preventable accidents. The plan provides that the group making the greatest percentage of reduction in time lost due to accidents during each three months' period in the year 1928 will be awarded a grand prize of $1,000 in gold. To the groups making the second and third best showing will be awarded $500 and $250 respectively.

E. M. NORRIS, assistant superintendent of the east side or Boston & Montana group of the Anaconda Copper Mining Company, will take charge of the company's phosphate property at Conda, Idaho, succeeding C. E. NIGHMAN, who will take charge of coal mines in Poland in which the Anaconda company is interested. Mr. Norris, a graduate of Columbia University, class of 1905, has been operating in Butte since his graduation, with the exception of a few years spent in Salt Lake and Nevada. H. J. RAHILLY succeeds Mr. Norris.

OBITUARY

EDWIN C. WOODWARD, 80 years old, prominent assayer of Colorado Springs, died on Jan. 4 after a short illness. Mr. Woodward was in all the great gold rushes of Colorado, California and Nevada.

IVOR REES, a well-known shaft sinker on the Rand, died recently at Glamorgan. He established a record in No. 15 circular shaft, at the Crown Mines, where in 31 days (in December, 1918) 279 ft. was accomplished, the size of shaft as broken being 21 ft. 6 in. This record has been beaten only once—by his own son, Arthur Rees, in 1921.

BENJAMIN W. WILSON, prominent Montana mining operator and promoter, died in Butte on Dec. 29 at the age of 52. He was the promoter of the Bismarck Mining Company and the Liberty Montana Mines Company, the latter company conducting successful operations at what is known as the Mammoth property in the Little Boulder district, near Cardwell, Mont.

RALPH NICHOLS, a mining engineer well known throughout the West, died recently in Illinois. The following appreciation by Senator Harry A. Gallwey, as presented in the *Anaconda Standard*, is reprinted, in part, through the courtesy of Mr. R. M. Raymond, professor of mining at Columbia University:

Ralph Nichols was born at Nyack, N. Y., on Feb. 2, 1855; and was graduated as C.E. and M.E. at Columbia in the class of 1879. He married Miss Florence Cooley at Aurora, Ill., in 1879, and went to Leadville, Colo. The same year he joined the surveying firm of Nichols, Page & Bow. In 1882 Mr. Nichols took charge of the Viola mine, at Nicholia, Idaho; the town was named after him. In 1888 he went to Nevada, where he was manager of the famous Sutro tunnel property of the Comstock Tunnel Company. From there he went to Hailey, Idaho, where he had charge of the Jay Gould Mining Company. The year 1893 found Mr. Nichols in Delamar, Nev., as superintendent of Delamar's Nevada Gold Mining Company, where he installed what was about the first practical cyanide mill. In 1897 he went to Kalgoorlie, West Australia, where he had charge of the Boulder Perseverance Company; and in 1906 to Durango, Mexico, as manager of the Avino Mines of Mexico, where he remained for several years. He then returned to Gilmore, Idaho, to work his own property, "The Latest Out," a mine he located in the early 'eighties, of which he always spoke as his "grubstake." This property turned out to be a good-paying lead-and-silver mine. Mr. Nichols' career was a varied and successful one. He was of a retiring disposition, but was always ready to extend aid and assistance to those not so fortunate as he. He will be mourned by many friends. Mr. Nichols had been a member of the A.I.M.E. since 1893.

Market and Financial News

African Copper Shares Decline in London Market

AN INTERESTING explanation of the recent declines of shares in the various companies that are operating or developing copper properties in Northern Rhodesia is offered by the London correspondent of the *Boston News Bureau*. The following are excerpts:

"A belated awakening to a realization that it costs several times as much to develop and equip a copper mine as it does a gold or tin mine is responsible for the declines in Rhodesian copper share prices. Bwana M'Kubwa is selling for less than half its high price of a year ago, N'Changa for 50 per cent of the 17s. 6d. per share paid in, Rhodesian Congo Border is down from 145s. to 28s., and the other prospecting concessions companies' stocks are generally below par.

"London has had little experience in copper-mining financing. Few if any of its investors have worked out with pencil and paper that the world's annual copper producing capacity has been created, chiefly by Americans, at a cost of over $700 a short ton, or that it is capitalized on the stock exchanges today at nearly two and a half times this amount.

"The promoters of the Rhodesian copper mining enterprises did not create any smoke-screen to conceal this fact. They have been frank, their only mistake being due to their assumption that everyone must know the expense of creating big producers would be great.

"At the first meeting of Roan Antelope Copper Mines it was stated that probably £2,500,000 additional would be required to equip that property for a production of 45,000 tons of copper annually. Bwana M'Kubwa shareholders were told that £2,000,000 may be needed a year hence to equip the N'Kana property to produce 50,000 tons of copper annually.

"Some disappointments have been met. Bwana M'Kubwa has had trouble in treating its ores as others have had in the initial stages of their mining operations.

"Then, again, Rhodesian Congo Border did not prove up any new mines last year. After developing 120,609 tons of ore averaging 4.3 per cent in its eastern, or Porphyry, district, in five detached deposits it suspended operations there; but the intention is to resume when conditions are more favorable.

"Though 41,000 tons of 12 per cent copper ore was developed at Chifumpa by drifting and cross-cutting at the 100-foot level, distance from transportation facilities caused this work to be suspended by Rhodesian Congo Border, and attention has been given chiefly to prospecting the company's huge concession. The number of mineral discoveries made so far is 140.

"At N'Changa the vertical shaft went down in broken ground and was abandoned. Another site was selected, drilled to determine its character and a new shaft is being sunk. At the end of November the two incline shafts were down 740 and 682 ft. respectively, and below the 600 level had been connected by a drift. This work is confirming the values indicated by drill holes. So far over 8,000,000 tons averaging 3.74 per cent copper have been proved, the lode at this point being approximately 53 ft. wide.

"The London interests in these African copper enterprises are showing no disposition to pause with the work of discovering, developing and equipping ore deposits, or to call on America for financial assistance.

"It works out, from the Bwana M'Kubwa and Roan Antelope estimates, that the cost of creating annual producing capacity in Africa will be about $350, or half what it has cost on the average in America."

Japanese Increase Imports of Aluminum

USE of aluminum for wire-drawing and other industrial purposes and the manufacture of aluminum utensils in Japan has grown greatly during the last five years, according to a report from Consul E. R. Dickover, of Kobe, Japan. Official statistics show imports of 8,812,000 lb. in 1922, 9,230,400 lb. in 1924, 10,417,000 in 1925, and 16,767,300 in 1926, compared with an annual pre-war consumption of about 1,250,000 lb.

Sources of the Japanese imports of aluminum vary considerably from year to year, depending upon the prices prevailing in the countries of origin, the exchange rates, and other circumstances.

Before 1912 Europe supplied the entire Japanese demand, but in that year the United States entered the market with 23 per cent of the total importation, the bulk of the supply in preceding years having come from Great Britain, Germany, and France. There was marked variation in the following years in the proportion received from the United States, which furnished the entire supply in 1916, but the general tendency in the past few years seems to be upward, although the American share is still much smaller than it was from 1916 to 1919 inclusive.

Detailed statistics for 1926 are not yet available, but indications are that as large a proportion of American aluminum was imported then as in 1925. In the preceding years the American share increased rapidly, from 1,254,000 lb. or 14 per cent in 1922 to 2,281,100 lb. or 28 per cent in 1923 and 6,735,400 lb. or 64 per cent in 1925. The year 1927 is expected to show further increases in consumption.

Dividend "Ups and Downs" in 1927

THE following tabulation shows the mining companies in the United States that increased their dividend distributions during the year 1927 compared with 1926. It will be observed that there is little uniformity in the lists. Some companies paid more and some less among the lead, copper, gold, silver, iron and miscellaneous groups.

Increases

Copper

Calumet & Hecla, Michigan.
Kennecott, various.
Miami, Arizona.
Nevada Con., Nevada, Arizona, New Mexico.
New Cornelia, Arizona.
Phelps Dodge, Arizona, Mexico.
Utah, Utah.
United Verde, Arizona

Lead-Zinc-Silver

Bingham, Utah.
Caledonia, Idaho.
Cardiff, Utah.
Douglas, Idaho.
Eagle-Picher, Missouri, Oklahoma.
National Lead, various.
Park-Utah, Utah.
Plutus, Utah.
Sunshine, Idaho.

Miscellaneous

Aluminum Company, various.
A. S. & R., various.
Freeport Texas, Texas.
Golden Cycle, Colorado.
Newmont, various.
Republic Iron & Steel, various.
U. S. Steel, various.
Texas Gulf Sulphur, Texas.
Vanadium Corp., various.

Decreases

Copper

Arizona Commercial, Arizona.
Engels Copper, California.
Inspiration, Arizona.
Mother Lode, Alaska.
Ohio Copper, Utah.
Tennessee Copper, Tennessee.

Lead-Zinc-Silver

Betty O'Neal, Nevada.
Butte Copper & Zinc, Montana.
Chief Con., Utah.
Consolidated Lead & Zinc, Missouri, Oklahoma.
Federal M. & S., Idaho, Oklahoma.
Gladstone Montana, Washington.
Hecla, Idaho.
Keystone, Utah.
Mammoth, Utah.
Utah-Apex, Utah.

Miscellaneous

American Metal, various
Cleveland-Cliffs, Michigan
Inland Steel, various.
Portland, Colorado.
Tom Reed, Arizona.

STATISTICAL NOTES

ALASKA JUNEAU GOLD MINING COMPANY reports December gross receipts of $215,000, comparing with $221,000 in December, 1926, and a surplus of $19,000 after taxes and interest and expenditures for Ebner mine development, against $13,750. Gross receipts for 1927 amounted to $2,270,000 and surplus after taxes, interests, and mine development work was $4,400.

CHILE COPPER COMPANY reports net income for the quarter ended Sept. 30, 1927, of $2,777,863 after depreciation, federal taxes and interest, and amortized discount on 6 per cent convertible bonds. This is equivalent to 62c. a share earned on 4,415,495 shares, and compares with $2,764,263 (62c. a share) in the previous quarter, and $2,427,427 in the third quarter of 1926.

The Market Report

Higher Volume of Metal Sales at Steady Prices

New York, Jan. 11, 1928—Consumers have again entered the market after the holiday lull, so that sales of most of the non-ferrous metals have been of close to average volume in the week ending today. Prices, in general, have shown little change, with the exception of tin, which has declined over a cent during the week in view of a depressed market in London. In fact, all the metals have been weaker in London in the last two or three days.

Daily Prices of Metals

Jan.	Copper	Tin		Lead		Zinc
	Electrolytic, N. Y.	99 Per Cent	Straits	N. Y.	St. L.	St. L.
5	13 90	56.25	56.625	6 50	6 30	5 65
6	13 90	56.00	56.50	6.50	6 30	5.65
7	13 90	56.125	56.75	6.50	6.30	5.65
9	13 90	56.125	56.875	6 50	6 30@6.325	5 65
10	13.825@13 925	55.50	56.125	6.50	6 30@6.325	5 65
11	13.825@13.90	55.625	56 375	6.50	6.30	5 65
	13.890	55.938	56.542	6.500	6 304	5.650

Average prices for calendar week ending Jan. 7, 1928, are: Copper, 13.890; 99 per cent tin, 56.525; Straits, 57.000; N. Y. lead, 6.500; St. Louis lead, 6.305; zinc, 5.643; and silver, 57.650.

The above quotations are our appraisal of the major markets for domestic consumption based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

Copper, lead, and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

In the trade, copper prices usually are quoted on a delivered basis; i.e., delivered at consumer's plant. As delivery and interest charges vary with the destination, the figures shown above are net prices at refineries on the Atlantic seaboard. Delivered prices in New England average 0.225c. per pound above those quoted, and prices at so-called Middle West destinations, 0.325c. above.

Quotations for copper are for ordinary form of wire bars, ingot bars, and cakes. For ingots an extra 0.05c. per pound is charged and there are other extras for other shapes. Cathodes are sold at a discount of 0.13c. per pound.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York is now quoted at 0.35c. per pound above St. Louis, this being the freight rate between the two points.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

London

Jan.	Copper			Tin		Lead		Zinc	
	Standard		Electrolytic						
	Spot	3M		Spot	3M	Spot	3M	Spot	3M
5	62 1/16	62 1/16	66 1/2	256 3/4	256 3/8	21 15/16	22 3/8	26 1/4	26 1/4
6	62	62	66 3/4	256 1/4	255 3/4	21 15/16	22 3/8	26 1/4	26
9	61 7/16	61 13/16	66 3/4	258	257 1/4	21 15/16	22 5/16	26 3/16	26
10	61 11/16	61 9/16	66 1/2	254 1/2	254	21 7/8	22 1/4	26 1/4	25 7/8
11	61 1/8	61 1/16	66 1/2	254 1/4	252 3/4	21 13/16	22 1/4	26	25 13/16

The above table gives the closing quotations on the London Metal Exchange. All prices in pounds sterling per ton of 2,240 lb.

Silver, Gold, and Sterling Exchange

Jan.	Sterling Exchange "Checks"	Silver		Gold London	Jan.	Sterling Exchange "Checks"	Silver		Gold London
		New York	London				New York	London	
5	4.87 7/16	57 7/8	26 11/16	84s11 1/4d	9	4.86 7/8	57 5/8	26 1/2	84s11 1/2d
6	4.87 1/2	57 3/4	26 5/8	84s11 1/2d	10	4.86 7/8	57 5/8	26 1/2	84s10 1/2d
7	4.86 7/8	57 1/2	26 9/16	.....	11	4.87	57 5/8	26 1/2	84s11 1/2d
					Avg.		57.667		

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of bar silver, 999 fine. London silver quotations are in pence per troy ounce of sterling silver, 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command three-eighths of a cent premium.

Copper Sales Improve

Though it is the general impression that the copper market is very quiet, the total domestic sales have been the highest since the first week of December, and not far below an average week's business in 1927. Buying has been fairly well distributed between rolling mills and brass manufacturers. More than the usual proportion has been taken by Middle Western consumers, reflecting greater activity in automobile lines, especially Ford. Shipment has been well divided between February and March, with some scattering orders for April. Indications are that half of February requirements of copper have been purchased and from 10 to 20 per cent of those for March.

Most sellers continue to quote the Eastern market at 14⅛c., delivered, and the Middle West, 14¼c., practically all taking their share of the business at those levels. Some odd lots have been sold by others at concessions, however, a brass manufacturer being able to pick up a round lot yesterday, for instance, at 14.05c., delivered Valley. The weaker quotations in London standard copper have resulted in several offerings through irregular channels at various prices between 14 and 14.075c. delivered, which have been well absorbed.

The export market has done very well so far this month, the association marketing on the average around 2,000 tons a day at the unchanged price of 14½c., c.i.f. Business for the last two days, however, has dropped off markedly.

Lead Quiet and Steady

Though the total volume of sales of lead during the week has not been large, inquiry has been better the last day or two, and prices have been steady. The American Smelting & Refining Company has continued to maintain its New York contract price at 6.50c., and this figure has also prevailed in the outside market. The leading interest in the Middle West has obtained 6.325c. on some orders, though regular customers have made purchases at 6.30c. One or two other sales at 6.325c. are reported for March-April delivery, the position being the reason for the higher price. London has declined steadily, though slowly, and the margin favoring the foreign market for Mexican bullion lead is only $2 or $3 per ton. However, the tone of the domestic market is good, "mixed-metal" manufacturers being particularly conspicuous buyers, and no reason for any marked change in the situation is apparent.

Zinc Holds at 5.65c.

Zinc has been in improved demand in the last week, Monday being an especially good day with regard to volume of sales. The slight increase in ore prices in the Tri-State field was followed by increased quotations by some producers, but others were willing to sell at 5.65c. for any delivery, and at that level did an excellent business.

A few odd sales were made during the week at 2½ points above and below that level. No particular encouragement for zinc producers can be gleaned from the December statistics of the American Zinc Institute, which are as follows, in tons of 2,000 lb.:

	Dec., 1927
Stock Dec. 1	39,320
Produced	52,347
Shipped	50,916
Stock, Dec. 31	40,751
Shipped from plants for export	4,433
Sold but not delivered, Dec. 31	23,536
Total retort capacity, Dec. 31	131,484
Number retorts operating, Dec. 31	77,084

Total production for 1927 was 613-548 tons; shipments, 594,684 tons.

Some Activity in Tin

Consumers in the domestic market have been buyers of tin during the week on breaks in the price. Dealers, on the other hand, have been inclined to sell. Last Thursday prompt metal commanded a slight premium, but since then all positions have been practically the same price. A fire in New York harbor on the steamship "President Polk," carrying 740 tons of Straits tin, has had the effect of stiffening the price for prompt Straits today.

Silver Quiet and Inactive

The silver market has been very quiet and inactive during the last week, the quotation varying between 57½ and 57⅞c. Moderate support from China in the absence of any pressure to sell has kept the market steady. India has shown very little interest at prevailing rates.

Mexican Dollars (old Mexican pesos): Jan. 5th, 44½c.; Jan. 6th, 44⅜c.; Jan. 7th, 44⅜c.; Jan. 9th, 10th, and 11th, 44¼c.

Foreign Exchanges Quiet

Foreign currencies are substantially unchanged from last week. Closing cable quotations on Tuesday, Jan. 10, were as follows: Francs, 3.93c.; lire, 5.28⅞c.; and marks, 23.81c. Canadian dollars, ⅛ per cent discount.

Other Metals

Quotations cover large wholesale lots unless otherwise specified. London prices are according to latest mail advices.

ALUMINUM—Per lb., 98 or 99 per cent grade, price of leading interest, 24.30c.; outside market, 23.90@24.30c.

ANTIMONY—Per lb., duty paid. New York: Chinese brands, spot business, range for the week 10¾@10⅞c. Forward positions through March about ⅛c. higher.

Cookson's "C" grade, spot, 16½c. Needle antimony nominally 8c. for lump and 10c. for powdered. White oxide, Chinese, 99 per cent Sb_2O_3, 15½c.

BISMUTH—Per lb., New York, in ton lots, $1.85@$2.10. London, 8s.

IRIDIUM—Per oz., $350@$400 for 98@99 per cent sponge and powder. Strong market; shortage of supply.

NICKEL—Per lb. ingot, 35c.; shot, 36c.; electrolytic, 37c. (99.9 per cent grade) for single lots of spot metal.

PALLADIUM—Per oz., $50@$52. Small lots bring up to $56.

PLATINUM—Official price quoted by the leading interest on small miscellaneous orders for refined metal, per oz., $72. Dealers and refiners quote the trade for refined metal, per oz., cash, $72@$73. Market moderately active at firmer prices. Platinum as well as rhodium and ruthenium is strong as a consequence of the phenomenal rise in iridium.

QUICKSILVER—Per 76-lb. flask, range for week, $124@$125, depending on quantity. Market very quiet. San Francisco wires $128. London, £23; market firm.

RHODIUM—Per oz., $55@$60.

RUTHENIUM—Per oz., $60@$65. Market strong.

Prices of Cadmium, Cobalt, Germanium Oxide, Lithium, Magnesium, Molybdenum, Monel Metal, Osmium, Radium, Selenium, Tantalum, Tellurium, Thallium, Tungsten, and Zirconium are unchanged from the issue of Jan. 7.

Metallic Ores

MANGANESE ORE—Per long ton unit of Mn. c.i.f. North Atlantic ports, minimum 47 per cent Mn; 35@38c. Caucasian, washed, 53@55 per cent, 38.50@40c. Chemical grades unchanged from quotations in the Jan. 7 issue.

TUNGSTEN ORE—Per unit of WO_3, N. Y.; Wolframite, $10.25@$10.50. Western scheelite, $10.50@$10.75. Market dull, but asking price steady.

Chrome, Iron, Tantalum, and Titanium ores are unchanged from quotations in the Jan. 7 issue.

Zinc Ore Demand Good

Joplin, Mo., Jan. 7, 1928

Blende	Per Ton
High	$38.60
Premium blende, basis 60 per cent zinc	$37.00@ 38.00
Prime Western, basis 60 per cent zinc	36.00
Fines and slimes, 60 per cent zinc	32.00@ 35.00
Average settling price, all zinc	36.51
Galena	
High	$86.00
Basis 80 per cent lead	85.00
Average settling price, all leod	85.04

Shipments for the week: Blende, 6,485; lead, 2,098 tons. Value all ores the week, $415,390.

The shipment was 45 tons more than the output, and the purchase today for next week's shipment was 1,530 tons more than the output. The holders of reserve stocks declined to accept the advance of $1, and this ore is in the hands of companies financially able to continue holding indefinitely. Reports are made of several mines being closed for some weeks, one company reporting five mines shut down for two months. Estimates suggest an output averaging less than 10,000 tons per week during January.

Platteville, Wis., Jan. 7, 1928

Zinc Blende	Per Ton
Blende, basis 60 per cent zinc	$37.75
Lead Ore	
Lead, basis 80 per cent lead	$85.00

Shipments for the week: Blende, 664 tons: lead, none. Shipments for the year: Blende, 664 tons: lead, none. Shipments for the week to separating plants, 1,030 tons blende.

Non-Metallic Minerals

Amblygonite, Asbestos, Barytes, Bauxite, Borax, Celestite, Chalk, China Clay, Diatomite, Emery, Feldspar, Fluorspar, Fuller's Earth, Garnet, Gilsonite, Graphite, Greensand, Gypsum, Iron Oxide, Lepidolite, Limestone, Magnesite, Mica, Monazite, Ocher, Phosphate, Potash, Pumice, Pyrites, Quartz Rock Crystal, Silica, Spodumene, Sulphur, Talc, Tripoli, and Zircon are unchanged from prices in the Jan. 7 issue.

Metallic Compounds

ARSENIOUS OXIDE (White Arsenic)—Per lb., 4c. Market slack. London. Cornish white, per long ton, £18¼.

Calcium Molybdate, Copper Sulphate, Sodium Sulphate (Salt Cake), Sodium Nitrate, and Zinc Oxide are unchanged from prices in the Jan. 7 issue.

Ferro-Alloys

FERROMANGANESE—Per long ton, domestic and foreign, f.o.b. furnace or c.i.f. port of entry, $100 quoted for first quarter, 1928. Spiegeleisen, 19@21 per cent, $30@$31 f.o.b. furnace.

FERROTUNGSTEN—Per lb. of W contained, 75@80 per cent, 93@95c. f.o.b. works. Dull.

Ferrocerium, Ferrochrome, Ferromolybdenum, Ferrophosphorus, Ferrosilicon, Ferrotitanium, and Ferrovanadium are unchanged from prices in the Jan. 7 issue.

Metal Products

ROLLED COPPER—Sheets, 22¾c.; wire, 15¾@16c. per lb., f.o.b. mill.

LEAD SHEETS—Full rolled 10c. per lb.; clipped, 10¼c.

NICKEL SILVER—29¼c. per lb. for 18 per cent nickel Grade A sheets.

YELLOW (MUNTZ) METAL—Dimension sheets, 19¾c. per lb.; rods 16¾c. per lb.

ZINC SHEETS — 10c. per lb., f.o.b. works.

Refractories

Chrome Brick, Fireclay Brick, Magnesite Brick, Silica Brick and Zirkite are unchanged from quotations in the Jan. 7 issue.

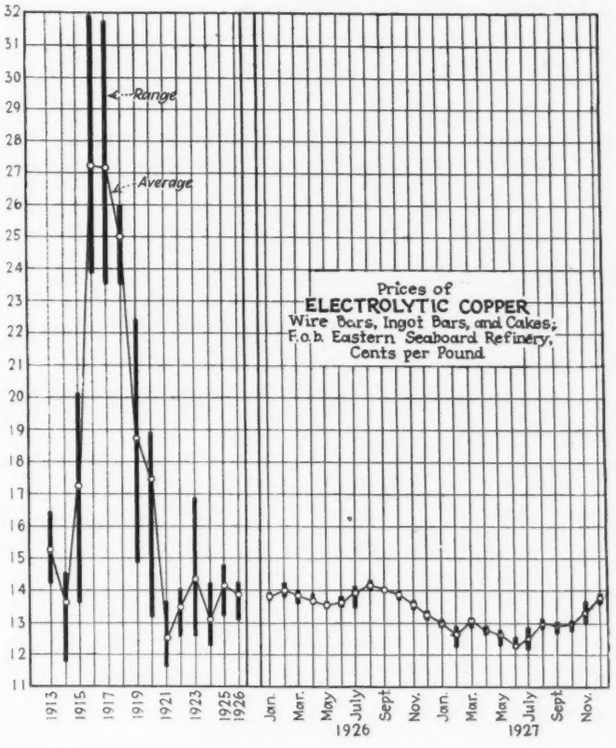
Iron, Steel, and Coke

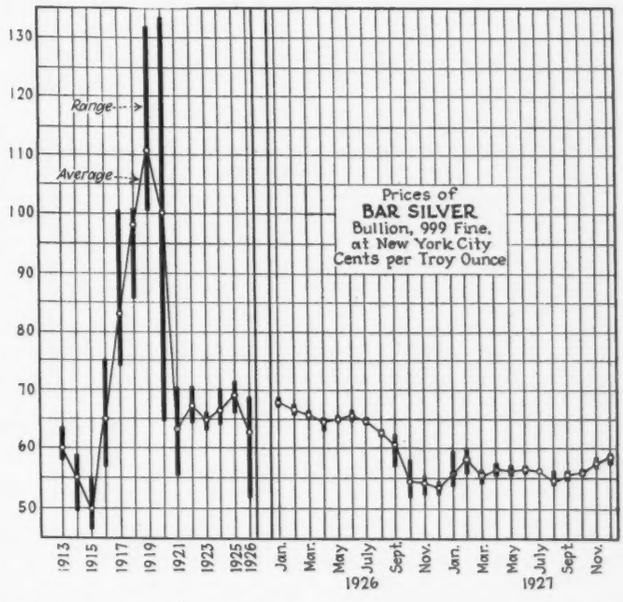
Iron—Per gross ton, Valley furnaces, Bessemer, $17.50; basic, $17; No. 2 foundry, $17.25@$17.50.

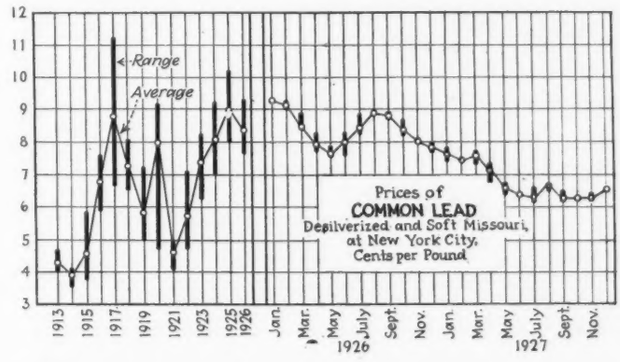
Steel—Base prices per gross ton, Pittsburgh, billets and slabs, $33; plates, structural shapes, and soft steel bars, per pound, 1.80c.

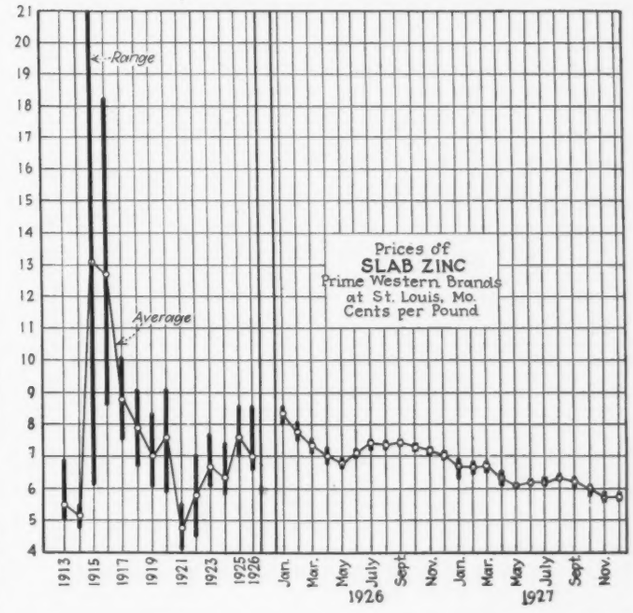
Coke—Per gross ton, Connellsville furnace, contract, $2.85@$3; spot, $2.75@$3. Connellsville foundry, contract, $3.75@$4.75; spot, $3.50@$4.75. By-product coke, Ohio and Kentucky, $7.50; Buffalo and Detroit, $9.

Metal Price Curves

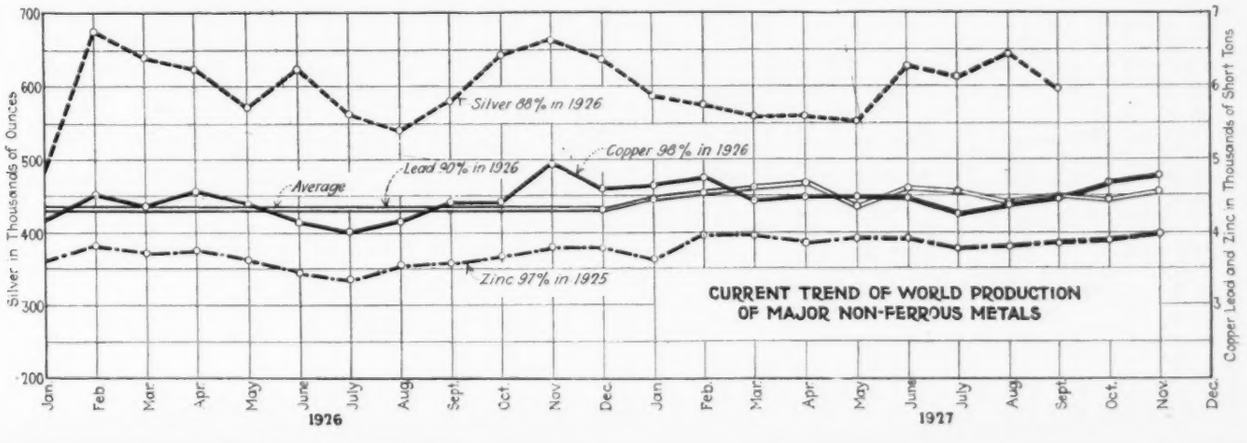








THE CURVES below are not to be considered as permanent records of production. They show merely the current trend in terms of daily output according to the latest estimates of the American Bureau of Metal Statistics. The figures represent production from countries that produce approximately 98 per cent of the world's copper, 97 per cent of the zinc, 90 per cent of the lead, and 88 per cent of the silver. The figures for lead on the new basis are not available for the individual months of 1926, and accordingly a horizontal line showing the monthly average reduced to a daily rate is shown. Delay in receipt of statistics from Mexico accounts for the failure of the silver curve to be up to date.



Review of Current Statistics

By A. B. Parsons
Associate Editor

ONLY a casual examination of the accompanying statistics (pages 77 and 79) is required to detect three significant comparisons between those for 1927 and those for 1926. (a) Most striking perhaps is the advance in all three Indexes of the Stock Market Valuation of Common Shares. During the entire year they were much higher than in 1926, and the sharp advances during recent months widened the margin to a phenomenal extent. (b) The Weighted Index of Non-Ferrous Metal Prices was 10 per cent lower than in 1926, the averages for the two years being 97.54 and 107.74 respectively. Individual curves for the four major metals, shown on page 77, disclose the fact that each of the four—copper, zinc, lead, and silver—averaged decisively lower than in the former year. (c) Production rates of the major metals continued high, both in the world, as indicated at the bottom of page 77, and in North and South America. Although mine output of lead, zinc, silver and copper in the United States declined slightly, this was more than offset by increases in Canada and Mexico.

One may fairly ask why it is that the trend of the valuation of metal mining enterprises, as appraised by the public in accordance with the prices it is willing to pay for the shares, has been so strongly upward, coincidentally with the all-round decline in prices for the metals that the mining companies produce and sell. Probably most important is a factor that has no direct connection with metal markets nor the profits of metal mines—namely, the desire of Wall Street's multitudinous patrons to buy something, anything and everything. Money has been plentiful and credit cheap. The result has been an active bull market, and mining shares have participated in the general march upward. There have been more buyers than sellers; and when the public is in this mood no specific reason need be found for its selection of stocks.

A second reason is that profits, generally speaking, have not shrunk in proportion to the decline in the prices realized for the metals. In other words, average production costs have been further reduced. Selective flotation has been a factor in this lowering of costs; and other economies have been effected. Taking 10 per cent from the selling price of its product would represent a decrease of 50 per cent or more for many mining companies; and the fact that earnings were not squeezed drastically indicates reduction in costs.

It is a fact that in some instances valuable new orebodies have been developed, and that this has enhanced the intrinsic value of the shares. This is true of International Nickel, Calumet & Arizona, and Magma; also of Bunker Hill & Sullivan, through its Ontario holdings, and of A. S. & R. Co. and Anaconda through sundry subsidiary companies. Greene Cananea is conspicuous in this group, but it happens not to be among the companies used in calculating any of the indexes. With a few exceptions it cannot be said that the opening of important new deposits has been a decisive factor in the strength of the share market.

E.&M.J. Weighted Index of Non-Ferrous Metal Prices

100 Is Composite for 1922-3-4

1920	130.92
1921	80.80
1922	93.94
1923	103.43
1924	102.63
1925	111.74
1926	107.74
1927	97.54

	1925	1926	1927
May	105.34	105.43	96.41
June	107.19	106.68	95.55
July	108.81	109.08	95.42
August	113.61	110.22	97.25
September	114.66	109.27	96.01
October	115.64	106.20	95.36
November	116.69	104.21	96.22
December	114.15	102.31	98.30

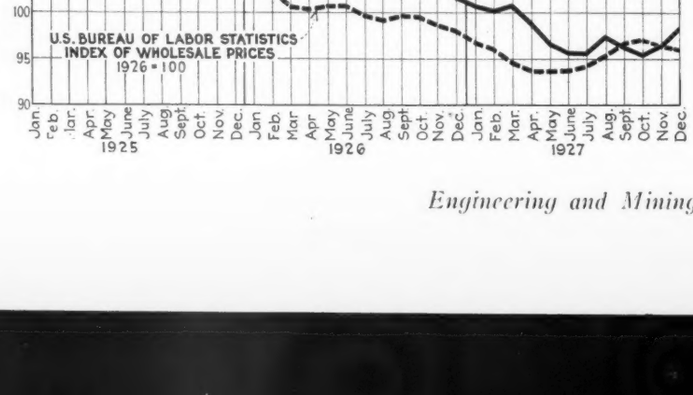
The third comparison, showing the maintenance of high production rates, contributes to the health of the industry. It shows that the average scale of operations was high; and this condition always helps keep costs down and earnings up.

One other point is significant: though copper averaged only 12.92c., refinery, for the full year in 1927, against 13.795c. for 1926, the figure for December, 1927, was 13.774c. compared with 13.302 for the corresponding month a year earlier. Moreover, the December average was far higher than any other month in the year; and December was the third consecutive month to witness improvement. Copper, in short, seems to be in a better position at the close of the year than for a long time; and this fact doubtless has been an element of strength in the market for copper shares, as revealed in the charts.

Aside from copper, it is to be noted that lead, silver, and tin, in the order named, contributed to the advance in the Weighted Index of Metal Prices from 96.22 in November to 98.30 in December. Aluminum and zinc declined, this being the third consecutive month of lower average prices for each of these metals. Zinc at 5.722c. is at the lowest level reached since 1922, but there are evidences that the market has about touched bottom. Silver has gone up four months in succession, the December average being 57.957c., the highest figure reached since before the drop of September, 1926.

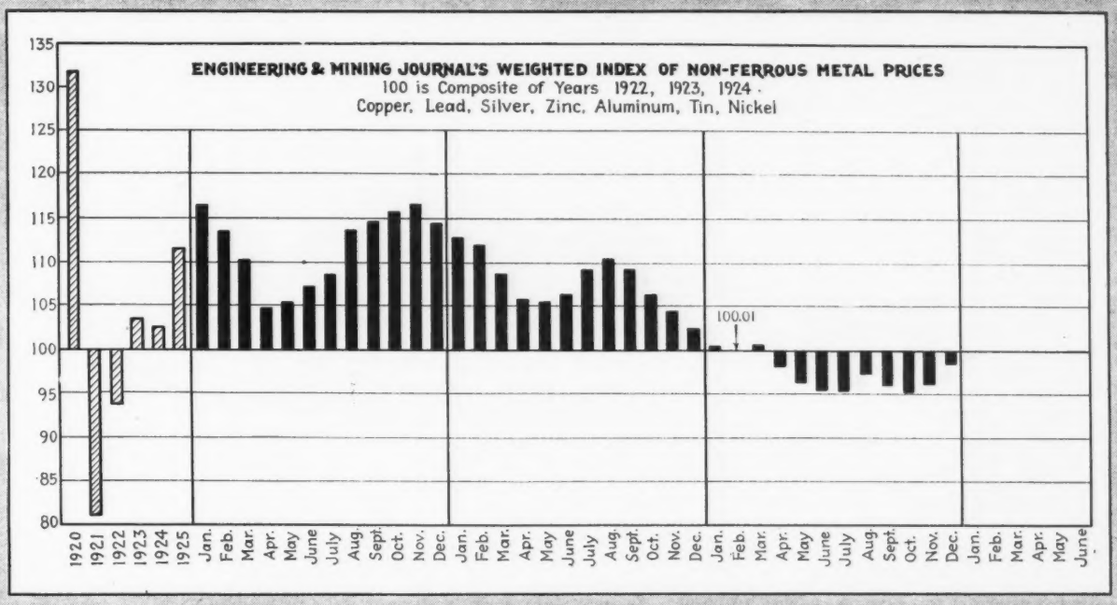
No change of consequence has occurred in the prices for non-metallic minerals, and the Weighted Index, at 106.21, is virtually the same as in November. Fluorspar is slightly easier; but, on the other hand, feldspar prices are fractionally higher.

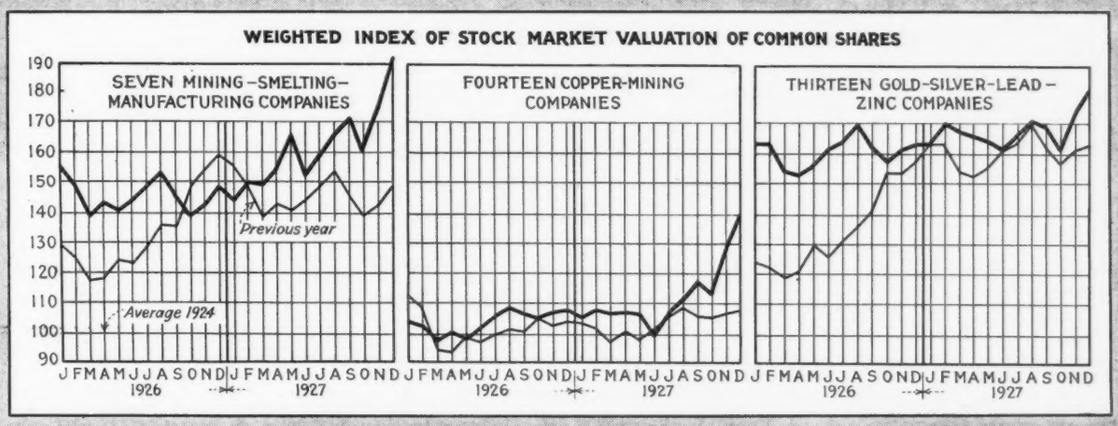
Of the companies in the mining-smelting-manufacturing group all increased except National Lead, which reacted slightly after a sharp advance in November. As a matter of fact, the closing quotations for the year were generally lower than the "highs" reached toward the end of the month. Anaconda, for example, touched $60, the highest reached since 1920; and A. S. & R. reached $185⅝, a new high for all time. The common stock of International Nickel, incidentally, is appraised on the stock market at $30,000,000 more than A. S. & R.! Among the big fellows in the copper list Kennecott, at $90⅜, and Chile, at $44½, reached new record highs. The only stock in the miscellaneous list to decline was Premier. The lead-silver stocks, particularly those in Utah, fared very well indeed. St. Joseph Lead and Hecla also advanced. Apparently the public has faith in lead—or is it merely the manifestation of the large supply of ready money that must be invested in something.

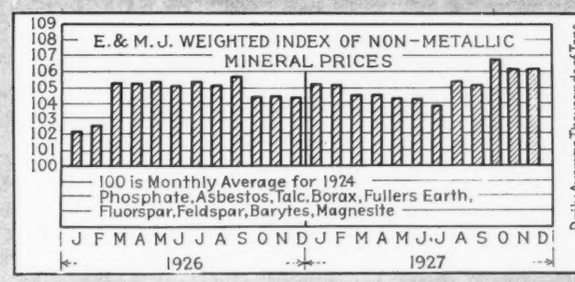


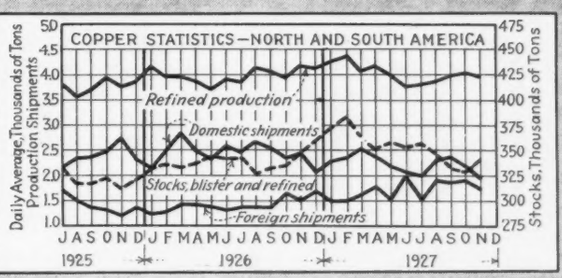
The accompanying graph, comparing the E. & M. J. Metal and the Bureau of Labor price indexes, shows that the position of the metals is distinctly better.

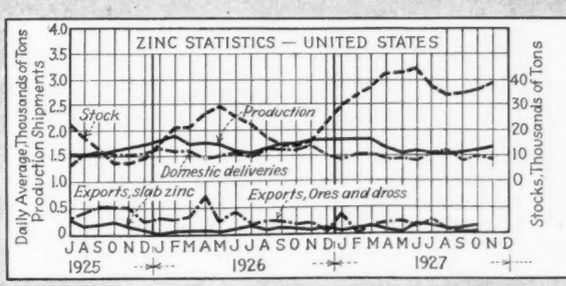
E.&M.J. Statistics of the Mining Industries

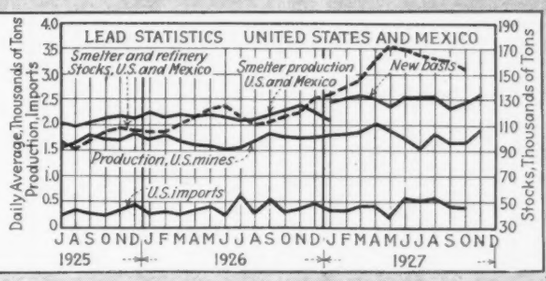

ENGINEERING & MINING JOURNAL'S WEIGHTED INDEX OF NON-FERROUS METAL PRICES
100 is Composite of Years 1922, 1923, 1924
Copper, Lead, Silver, Zinc, Aluminum, Tin, Nickel
100.01
1920 1921 1922 1923 1924 1925 1926 1927




E.& M.J. WEIGHTED INDEX OF NON-METALLIC MINERAL PRICES
100 is Monthly Average for 1924
Phosphate, Asbestos, Talc, Borax, Fullers Earth,
Fluorspar, Feldspar, Barytes, Magnesite
1926
1927







Mining Stocks—Week Ended January 7, 1928

Stock	Exch.	High	Low	Last		Last Div.
COPPER						
Anaconda	New York	59⅜	55½	57⅜	Ja.14, Fe.20 Q	0.75
Arcadian Consol.	Boston	3⅛	3⅛	3⅛		
Ariz. Com'l	Boston	6	5⅝	5⅝	Jy. 18, Jy. 30	0.25
Calaveras	N. Y. Curb			1⅜		
Calumet & Arizona	New York	120½	110½	111½	De. 3, De. 9 Q	1.50
Calumet & Hecla	Boston	23⅛	21⅜	22⅛	No.30, De.15 Q	0.5⅛
Cerro de Pasco	New York	69⅜	67	67⅜	Ja.12, Fe.8 Q	1.00
Chile Copper	New York	42⅛	40	41⅛	De. 2, De. 30 Q	0.62½
Con. Coppermines	N. Y. Curb	6⅛	5⅜	5⅜		
Copper Range	Boston	20⅛	17½	18½	Ap.2, My.2, A	1.00
Crystal Copper	BostonCurb	*75	*56	*66		
East Butte	Boston	2⅛	1⅜	1⅜	Dec. 1919	0.50
Granby Consol.	New York	43⅛	41⅛	41⅛	Jn.15 Jy. 1 Q	1.00
Greene Cananea	New York	164⅛	136	138	Nov., 1920	0.50
Howe Sound	New York	44⅛	42⅜	43⅛	De.31, Ja.16, Q	1.00
Inspiration Consol.	New York	21⅛	19⅛	20	Ma.17, Ap.4, Q	0.25
Iron Cap	Boston Curb			3		
Isle Royale	Boston	14⅜	14	14	Se. 30, Oc. 15, Q	0.50
Kennecott	New York	87	84	84⅞	De. 2, Ja 3 Q	1.25
Magma Copper	New York	50⅛	52	53	De.30, Ja.17 Q	0.75
Mason Valley	N. Y. Curb	1⅜	1⅛	1⅜		
Miami Copper	New York	19⅛	17⅜	19⅛	Fe.1, Fe.15, Q	0.37½
Mohawk	Boston	50	49	49⅛	Oc.31, De.1 Q	2.00
Montana-Idaho	Spokane	*44	*41⅜	*44		
Mother Lode Coal	New York	3⅛	2⅞	3	De.16, De.31	0.25
Nevada Consol.	New York	19⅛	18⅛	19	De.16, De.31 Q	0.37½
New Cornelia	Boston	29⅛	28⅛	29⅜	No.4, No.21 Q	0.50
Noranda	N. Y. Curb	23½	22⅜	22⅞		
North Butte	Boston	1⅛	*99	*99	Oct., 1918	0.25
Ohio Copper	N. Y. Curb	1 1/16	*86	*95	Sept. 1926	0.03
Old Dominion	Boston	12⅛	11⅛	12	Dec., 1918	1.00
Phelps Dodge	N. Y. Curb			130½	De.17, Ja.3 Q	1.50
Quincy	Boston	15⅛	14⅛	14⅞	March, 1920	1.00
Ray Consolidated	New York			15⅛	Ap.20, Ap. 30	0.25
St. Mary's Min. Ld.	Boston	31⅛	29	31	Fe.10, Ma.10	2.00
Seneca Copper	New York			2⅜		
Shattuck-Denn	Boston Curb	11⅜	11	11⅛		
Tenn. C. & C.	New York	11	10⅜	11	No.30, De.15, Q	0.12½
United Verde Ex.	N. Y. Curb	25⅛	25	25	Ja.4, Fe.1 Q	0.50
Utah Copper	New York	1.58	1.48⅛	1.48⅛	De.16, De.31 Q	1.50
Utah Metal & T.	Boston	1 1/16	1⅛	1⅛	Dec., 1917	0.30
Walker Mining	Salt Lake	*54	*51	*54		
NICKEL-COPPER						
Internat. Nickel	New York	93	81⅛	91⅜	De.16, De.31 Q	0.50
Internat. Nickel pfd.	New York	110⅛	110⅛	110⅛	Oc. 13, No. 1 Q	1.50
LEAD						
Gladstone Mtn.	Spokane	*12½	*10⅜	*12½	June, 1927	0.005
National Lead	New York	127¼	126⅛	127⅛	De. 16, De. 31 Q	1.25
National Lead pfd.	New York	116⅜	116⅛	116⅛	Ja.13, Fe. 1 Q	1.50
St. Joseph Lead	New York	43¼	41¼	42⅛	Ma.9, Ma.20, QX	0.75
ZINC						
Am. Z. L. & S.	New York			6	May, 1917	1.00
Am. Z. L. & S. pfd.	New York	41½	41	41	Nov., 1920	1.50
Butte C. & Z.	New York	4⅛	4⅛	4⅛	De. 9, De. 24	0.50
Butte & Superior	New York	10⅛	9⅛	9⅛	De.16, De.31 Q	0.50
Callahan Zn-Ld.	New York	2⅜	1⅞	2⅛	Dec., 1920	0.50
Consol.Lead&Zinc'A'	St. Louis	14⅜	14⅛	14⅛	Ma.15, Ap.1 Q	0.25
Eagle-Picher	Cincinnati	24⅞	22⅛	24	No.15, De.1 Q	0.40
Eagle-Picher pfd.	Cincinnati			117⅛	Jn.30, Oc.15 Q	1.50
New Jersey Zn.	N. Y. Curb	184⅛	180⅛	180½	No. 19, De. 10 X	2.00
United Zinc	N. Y. Curb	25	25	25		
Yellow Pine	Los Angeles	*45	*25	*25	Dec. 1925 Q	0.04
GOLD						
Alaska Juneau	New York	2⅛	1	1⅛		
Argonaut	Toronto	*33	*31	*31½		
Barry-Hollinger	Toronto	1.19	1.10	1.15		
Con.W.Dome L.new.	Toronto	*17½	*14½	*16½		
Cresson Consol. G.	N. Y. Curb	2	1⅞	1⅞	De. 31, Ja.10 Q	0.10
Dome Mines	New York	13½	12⅜	13⅜	De.30, Ja.20 Q	0.25
Golden Cycle	Colo.Springs	†1.74½	†1.73		No.30, De.10 Q	0.04
Hollinger Consol.	Toronto	18.10	17.85	17.85	Ja.1, Ja.27 M	0.10
Homestake Mining	New York	74½	70	74½	Ja.20, Ja.27 MX	1.50
Kirkland Lake	Toronto	2.75	2.56	2.58		
Lake Shore	Toronto	27.70	26.55	26.55	De.1, De.15 QX	0.20
McIntyre-Porcupine	New York	27½	27⅛	27⅛	De.1, De.1 Q	0.10
Portland	Colo.Springs	†*25	†*20		Ap.6, Ap.15, Q	0.02
Rand Mines	New York			48⅛	Au.22-29 Am.Sh.	1.52
Teck-Hughes	Toronto	10.80	10.08	10.35	Fe.1, X	0.15
Tom Reed	Los Angeles	*33	*31	*31	Dec., 1926	0.02
Tough-Oakes	Toronto	*78	*67	*74		
United Eastern	N. Y. Curb	*75	*45	*64	July, 1924	0.05
Vipond Cons.	Toronto	*85	*80	*81	Apr.1, Apr.15	0.03
Wright-Hargreaves	Toronto	6.40	5.95	6.05	Oc.17, No.1	0.05
GOLD AND SILVER						
Carnegie Metals	Pittsburgh	17	16⅛	17		
Con. Cortez	N. Y. Curb	*18	*18	*18		
Dolores Esperanza	N. Y. Curb			*50	July, 1923	0.05
Premier Gold	N. Y. Curb	2⅛	2 1/16	2 1/16	De. 15, Ja. 4	0.08
Tonopah Belmont	N. Y. Curb	1⅛	1 1/16	1⅛	Ma.15, Ap.4	0.08
Tonopah Extension	N. Y. Curb	*12	*11	*12	Apr. 1925	0.05
Tonopah Mining	N. Y. Curb	2 1/16	2⅛	2 1/16	Se.20, Oc.21	0.07½
West End Consol.	N. Y. Curb			*5	Mar., 1923	0.05
Yukon Gold	Boston Curb			*72	June, 1918	0.02
SILVER						
Beaver Consol.	Toronto	2.25	2.14	2.14	May, 1920	0.03
Castle-Trethewey	Toronto	*78	*75	*75		
Coniagas	Toronto	5.04	4.80	4.90	May, 1924	0.12½
Keeley	Toronto	*70	*66	*66	Se.1, Se.15	0.08
Lorrain Trout Lake	Toronto			*60	July, 1925	0.05
McKinley-Dar.-Sav.	Toronto	*20	*18½	*20	Oct., 1920	0.03
Mining Corp. Can.	Toronto.	4.55	3.80	4.45	Ja. 10, Ja. 25	1.50
Nipissing	N. Y. Curb.	5⅛	5⅛	5⅛	De. 31, Ja.20 Q	0.07½

Stock	Exch.	High	Low	Last		Last Div
SILVER-LEAD						
Ahumada	New York	3⅛	3⅛	3⅛	Ma. 25, Ap.4, QX	0.12½
Bingham Mines	Boston	56	55	55	Ja. 21, Fe. 1 Q	0.95
BunkerHill&Sullivan	N. Y. Curb			144	De. 31, Ja. 4 X	0.75
Cardiff M. & M.	Salt Lake	*89	*89	*89	F b. 5, 1927	0.10
Chief Consol.	Salt Lake	3.55	3.05	3.55	Nov., 1926 Q	0.10
Consti'nMng.&Mill'g	Spokane	*26	*23	*26		
Erupcion	Boston Curb	*50	*50	*50	De.17, Ja 3 Q	0.07½
Eureka Lily	Salt Lake	1.80	1.60	1.70		
Federal M. & S.	New York			147½	Ja.25, Jn.29 Spec.	3.10
Federal M. & S pfd.	New York	93	91½	93	No. 12 De 15 Q	0.25
Hecla Mining	N. Y. Curb	17⅜	17⅛	17⅛	No.15, De.15 Q	1.75
Highland-Surprise	Spokane	*15	*14	*14½		
Iron King Mining	Salt Lake	*79	*58	*71		
Keystone Mining	Salt Lake	*25	*25	*25	Au. 12, Au. 26	0.07½
Lucky Jim	Spokane	*30	*29	*30		
Lucky Tiger-Com	Kansas City	†8 00	†7 75		De.10, De. 20 X	0.12
Mammoth Mining	Salt Lake	2.50	2.10	2.50	Jn.10, Jn.20 Q	0.05
North Lily	Salt Lake	4.00	3.75	3.75		
Park Utah	New York	14½	9½	13	De. 15, Ja. 3 Q	0.20
Plutus Mining	Salt Lake			2.40	Oc. 25, No. 10 Q	0.10
San Rafael	San Fran.	*11½	*10½	*10½		
Silver King Coal.	Salt Lake	11	10	10	De. 24, Ja.2 X	0.35
Silversmith	Spokane	*20½	*20	*20	Oct., 1926 Q	0.02
Strattons Mines	Spokane	*48½	*47	*48		
Sunshine M. Co.	Spokane	1.25	1.20	1.25		
Tamarack-Custer	Spokane	*68	*58	*59	Sept., 1924	0.25
Tintic Standard	Salt Lake	14	13⅛	14⅛	De.20, Ja.3 QX	0.40
Utah-Apex	Boston	5⅛	5	5⅛	Oct., 1926	0.25
IRON						
Bethlehem Steel	New York	58⅛	56⅛	57⅛	Se. 2, Oc. 1	1.75
Cleveland-Cliffs Iron	Cleveland	105⅛	103	105	Oc. 15, Oc. 25 Q	1.00
Colorado Fuel & Iron	New York	80⅛	76⅛	79	May, 1921	0.75
Gt. North'n Iron Ore	New York	24⅛	22⅛	22⅞	Dec. 6, Dec. 28	0.75
Inland Steel	New York	63	59	59⅛	No. 15, De. 1 Q	0.62½
Replogle Steel	New York			12⅛		
Republic I. & S.	New York	61⅛	59⅛	61	No. 15, De. 1 Q	1.00
Republic I. & S. pfd.	New York	105⅞	105	105⅛	De. 14, Ja. 2 Q	1.75
Sloss-Sheffield S. & I.	New York			126	De. 10, De. 20 Q	1.50
Sloss-Shef. S.&I. pfd.	New York			110	De. 20, Ja.3 Q	1.75
U. S. Steel	New York	152⅜	148	150⅜	No. 30, De. 30 Q	1.75
U. S. Steel, pfd.	New York	139⅞	138⅜	139⅛	Oc.30, No. 29 Q	1.75
Virginia I. C. & C.	New York			36	Jan., 1924	1.50
Virginia I.C.&C. pfd.	New York	62⅛	62⅛	62⅛	De. 16, Ja. 3	2.50
DIAMONDS, PLATINUM, ALUMINUM, VANADIUM, TIN						
De Beers Consol.	New York			24	Jn. 26, Jn.30	1.45
So. Am. G. & P. New.	N. Y. Curb	2⅛	2⅛	2⅛		
Alum. Co. of Amer.	N. Y. Curb	125	122⅛	124⅛		
Alum. Co. of Amer.pf.	N. Y. Curb	106	105⅛	105⅛	De. 15, Ja1 Q	1.50
Vanadium Corp.	New York	66⅛	61⅛	63⅛	No. 1, No. 15 Q	0.75
Patino M. & E.	New York	26⅛	23⅛	24⅛	Ap 27, My. 5	1 sh.
ASBESTOS						
Asbestos Corp.	Montreal	35	33¾	34	Jan., 1926	1.50
Asbestos Corp. pfd.	Montreal	95	94⅛	95	De.31, Ja.16 Q	1.75
SULPHUR						
Freeport Texas	New York	106⅛	102⅛	104⅞	Ja.14, Fe.1 QX	1.75
Texas Gulf	New York	80⅛	77⅛	78⅛	De. 1, De. 15 Q	1.00
MINING, SMELTING, REFINING AND GENERAL						
Amer. Metal	New York	46⅛	44⅛	45⅛	No.19, De.1 Q	0.75
Amer. Metal, pfd.	New York	115½	111½	111½	No.19, De.1 Q	1.75
Amer. Sm. & Ref.	New York	184⅛	176⅛	181	De.31, Fe. 1 Q	2.00
Amer. Sm. & Ref. pfd.	New York	133⅛	133	133	De.31, Ma.1 Q	1.75
Consol. M. & S.	Montreal	257	254	254½	De. 31, Ja. 16 X	6.25
Newmont Mining	N. Y. Curb	137⅛	128	132½	Ja.3, Ja. 17	1.00
U. S. Sm. R. & M.	New York	45⅛	43⅜	44	Ja. 6, Ja. 14 Q	0.87½
U.S. Sm. R.&M. pfd.	New York	53⅛	53	53	Ja. 6, J3 14 Q	0.87½

* Cents per share. † Bid or asked. Q, Quarterly. SA, Semi-annually. M, Monthly. F, four weeks. I, Initial. X, Includes extra. The first date given is that of the closing of the books; the second that of the payment of the dividend.

Boston quotations courtesy Boston Stock Exchange; Toronto quotations those of the Standard Stock Exchange of Toronto, by courtesy of Arthur E. Moysey & Co.; Spokane, Pohlman Investment Co.; Salt Lake, J. A. Hogle & Co.; Colorado Springs, Colo., Henry Sachs.

LONDON QUOTATIONS—WEEK ENDED DEC. 24, 1927

Name	High	Low	Last	Date	Last Div. Amount
Aramayo Mines (25 frs.)	73/6	72/9	73/6	Nov., 1927	5 p.c. (†)
British Platinum (£1)	—/3	—/3	—/3	Feb., 1925	2½ p.c.
Burma Corpn. (10 rupees)	14/3	13/9	14/1½	Jan., 1928	6 annas*
Bwana M'Kubwa (5s)	4/3	3/10½	4/1½		
Camp Bird (2s)	2/7½	2/6	2/7½		
El Oro (£1)	3/3	3/—	3/3	Nov., 1924	2½ p.c.*
Esperanza (10s)	—/3	—/1	—/3		
Frontino & Bolivia (£1)	17/6	13/—	13/9	Jan., 1928	5 p.c.
Mexican Corpn. (£1)	9/3	7/9	9/—		
Mexico Mines of El Oro (£1)	18/9	15/—	17/6	Dec., 1926	3½ p.c.*
N'Changa Copper Mining	8/6	8/—	8/6		
Oroville Dredging (£1)	4/3	4/—	4/3	Dec., 1923	3½ p.c.
Ouro Preto (£1)	2/6	2/—	2/6	May, 1925	2½ p.c.
Rhodesian Congo Border (£1)	30/7½	25/—	27/6		
St. John del Rey (£1)	10/3	10/—	10 —	May, 1927	3½ p.c.
San Francisco Mines (10s)	28/8	27/10½	28/9	Jan.	25s.
Santa Gertrudis (£1)	17/1½	16/9	17/—	Jan., 1928	7½ p.c.
Selukwe (2s. 6d.)	8/10½	8/4½	8/4½	April, 1917	6¼ p.c
S. Amer. Copper (2s.)	1/3	—/7½	—/9	Nov., 1917	75 p.c.
Tanganyika (£1)	67/6	64/6	65 7½	Aug., 1927	7½ p.c.
Union Miniere du Haut-Katanga (Brussels)	11.425	11 375	11.400	July, 1927	182.60(‡)

* Free of British income tax. † Swiss francs and plus 15 p. c. bonus. ‡ Belgian frs. and free of taxation.